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PERFORMANCE TECHNICIAN

OCTANE AND ENGINE PERFORMANCE
THE PHYSICS OF LUBRICATION SYSTEMS
OIL PUMPS, DRIVES, PANS, AND PUMP SYSTEMS, PART 1

Vehicle Power & Performance Knowledge for Professionals

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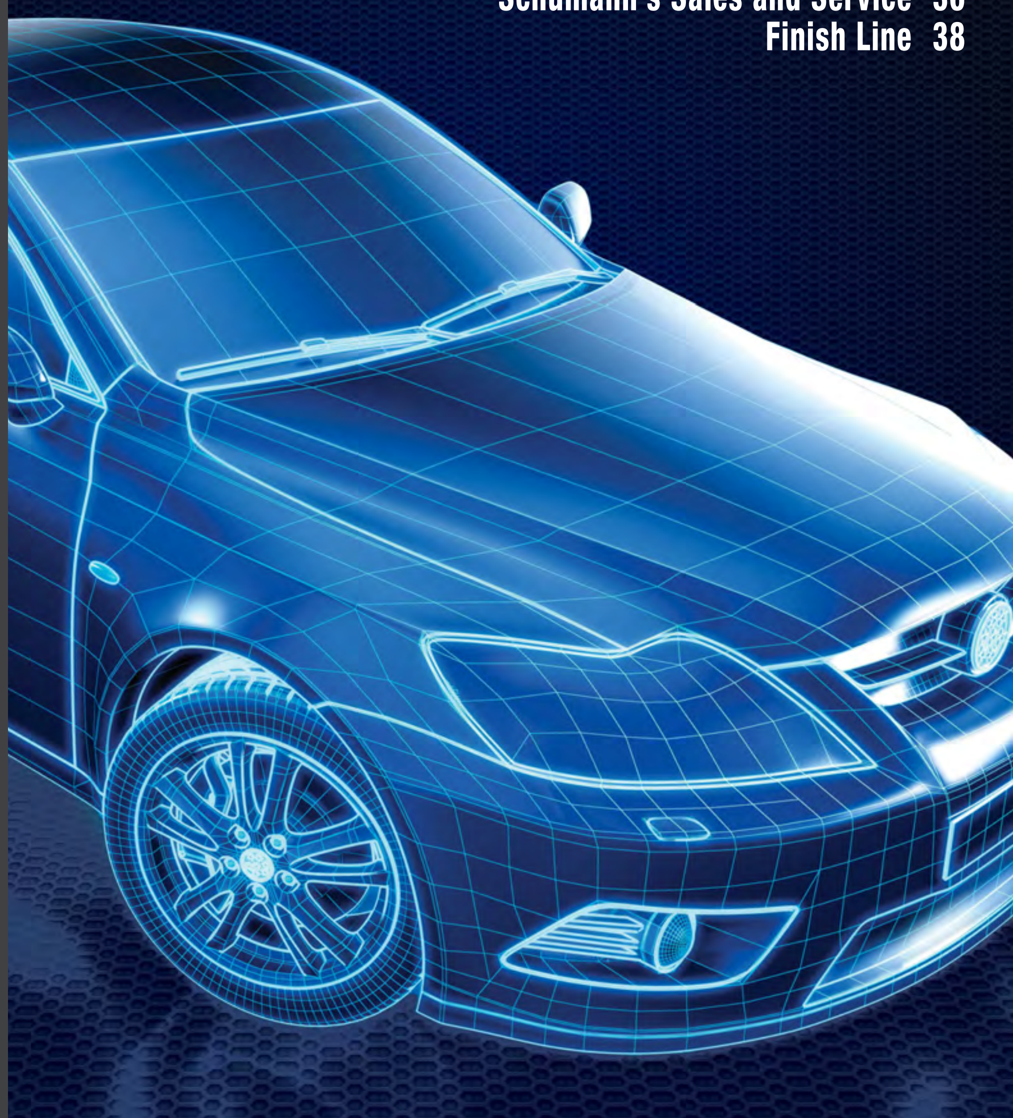
DEPARTMENTS



STARTING LINE

SO SOON?

-Robert Freudenberger

-Bob Freudenberger

Somewhere deep in the U.S. National Archives is a photograph from 1900 of New York City's Easter Parade on 5th Avenue. Engulfed in a sea of horse-drawn carriages, there's only one car.

Another photo from the George Grantham Bain Collection shows the 1913 NYC Easter Parade. All cars, one horse. That's a profound change, and in only 13 years. I've got shirts older than that.

This demonstrates that deep disruption in technology can occur in a much shorter time span than you'd ever suspect.

I've written before in this column about the electric-car phenomenon, but I'd never realized how imminent it was probably going to be until I watched an excellent presentation Tony Seba (author, thought leader, serial entrepreneur, and educator) gave in Oslo, Norway last year: Clean Disruption - Why Energy & Transportation will be Obsolete by 2030 (click https://www.youtube.com/watch?v=Kxryv2XrnqM&feature=youtu.be, or go to youtube.com and search for Clean Disruption). The title should've included the words, "as we know it," but that didn't detract from its impact.

The point Mr. Seba makes so convincingly is that we're in a similar transition right now as society begins the switch to electric vehicles (EVs). He based his analysis on the assumption that more and more EVs with a range of at least 200 miles will become available, and that their price will plummet so much that almost all new vehicles sold by 2025 will be electric -- that's only eight years away!

The New York City Easter parade in 1900. Many horses, one car.

Lower cost isn't the only thing that will promote the sales of EVs over those of internal-combustion-powered cars and trucks. Because electric motors deliver all their torque instantly, performance is terrific. The Tesla Model S, for instance, is just as quick 0-60 mph as any fabulously-expensive supercar. As long as the current they use is generated by clean means such as solar, wind, or hydroelectric, there'll be no air pollution. Even if they get their amperes from coal-burning plants, the atmosphere in cities will be vastly improved. Then there's a huge saving in fuel costs, almost as much as the price of a new car over the course of a decade or so, and, except for replacing tires and eventually battery packs, maintenance expenses will be almost nil -- an IC powered vehicle has many hundreds of parts in its powertrain, whereas that Tesla only has 18 (depending on what you count).

According to Mr. Seba (see tonyseba.com), those factors make this disruption inevitable. With all due respect, however, I think he neglected to mention a few important points. Even if he's right and all new cars will be electric in less than a decade, he doesn't factor in the millions of internal-combustion cars that will be sold up to that point, or all the late models on the road now. Currently, the world vehicle population is over 1.2 Billion, and their projected lifespan is 10 to 19 years, depending on whose statistics you're looking at and where you live (I still drive a 26-year-old Suburban with a 5.7L V8 and TBI). Will the owners of roadworthy cars and trucks scrap them just because EVs are available at reasonable prices? Will the cost of gasoline and diesel decline because of the reduced demand a substantial percentage of the electrics in our vehicle population will cause? If so, will people keep their fossil fuel-burning cars even longer? The answers to these questions are unknowable, but just the possibility that the price of gasoline may go way down should make PT readers happy.

The same occasion in 1913. See if you can find the solitary horse.

Will this transition affect the high-performance and vintage-car pursuits we're so passionate about? Probably not so much. It wasn't that long ago that I took a ride in a Stanley Steamer with its centuries-old technology, and I didn't see people pointing fingers at us for the big car's excessive carbon footprint. And nobody with similar DNA to mine is going to give up the thrilling sounds of a drag car with its ragged idle and screaming, thundering acceleration without a fight. I just can't see the whole hobby becoming socially unacceptable even in a politically-correct world, or being legislated out of existence. We may not make up a particularly large voting bloc, but we're solid. ■

OCTANE AND ENGINE PERFORMANCE

-Henry P. Olsen

It's been decades since you could just add more lead to combat detonation.

Programming an aftermarket fuel injection system is not always as simple as the instructions claim.

The octane rating of gasoline is a measurement of the fuel's ability to resist "pinging" or engine knock during the combustion process. The rating of most commercially-available gasoline will vary from 87 to 93. Also, it is blended for the expected temperature and the altitude in the area where it is sold, and to meet federal, state, and local environmental regulations. With the re-emergence of the high-performance engines that are available in late-model muscle cars and trucks, the use of high-octane gasoline is necessary if you are to expect maximum power from these engines.

The PCM (Powertrain Control Module) used with today's fuel-injected engines is continually tuning things such as valve timing, air/fuel mixture, and the amount of spark advance so the engine can provide the best power along with good fuel economy and the lowest possible exhaust emissions. The PCM does such a good job of adjusting the ignition advance that almost any engine can operate on 87 octane fuel without any pinging problems, so why would anyone pay extra for high-octane gasoline?

The reason you may want to buy premium fuel is that many new engines, particularly those with direct fuel injection, have compression ratios that are over 10:1 and sometimes as high as 12:1. These high compression ratios demand high-octane fuel if they are to perform as they should. FYI, my personal vehicle is a Ford Explorer Sport with the 3.5L EcoBoost engine that has 10:1 compression with twin turbo chargers. The owner's manual says it can run on 87 octane gasoline, but it also says for the best overall vehicle and engine performance premium fuel with 91 or higher octane is recommended (the engine horsepower and torque ratings were done with 93 octane).

OCTANE NEED

In general, there's no such thing as too much octane. Your engine only knows when it does not have enough, and that can cause serious damage especially if there are no knock/detonation sensors present. The things that cause an engine to need higher octane gasoline include:

- high compression ratios
- large cylinder bores
- cast iron cylinder heads
- lean air/fuel mixtures
- high engine coolant temperature
- aggressive spark advance curves
- high intake air temperatures
- intake air that is dry (low humidity)
- high barometric pressure conditions, especially those at sea level

Of course, turbocharging or supercharging develops higher cylinder pressures than does normal aspiration, and therefore needs more octane. These higher cylinder pressures will make more horsepower as long as the gasoline has a high enough octane rating. If detonation or spark knock occurs, power will drop off and the result can be a destroyed engine — even a knock sensor system retarding the spark advance may not be able to do enough.

DETONATION CONTROL

The PCM uses input from a knock sensor to identify a detonation/knock/pinging problem, and will retard the spark advance in increments of one to four degrees at a time up to a maximum of 20 degrees in

Low octane fuel combined with too much compression or spark advance can lead to serious engine damage.

The NOx reading on this portable 5-gas exhaust analyzer is an indicator of detonation.

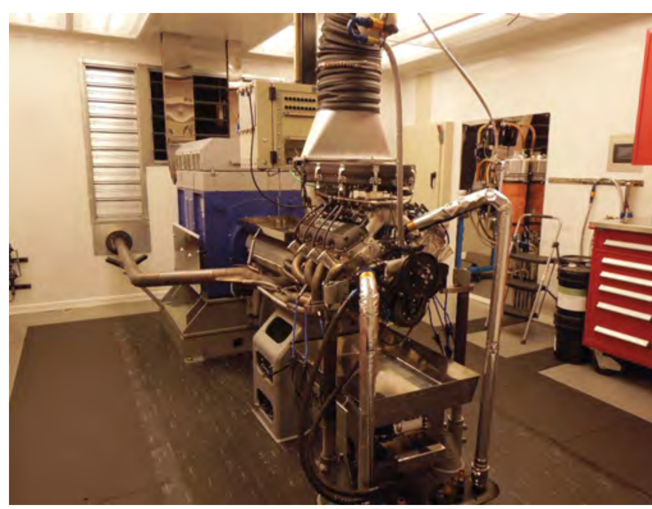
most applications. Spark control systems work so quickly you will never hear the knock, but when you operate an engine under high load conditions that was designed and power-rated on 93 octane fuel it will lose a lot of performance and horsepower on anything less. The loss of power is often 10% or more with regular 87 octane gasoline, thus the owner's manual will usually recommend that 93 octane premium be used when the vehicle is towing a trailer or operated under high load conditions such as might be encountered driving in the mountains.

The ignition spark advance system of most carburetor-equipped vehicles does not have a knock sensor, so if you want the engine to perform its best you should have its advance curve optimized for the octane of the fuel you buy. When the curve is correct, you will also avoid the catastrophic engine damage that can be the result of too much spark advance.

There are several methods to tell if a vintage carburetor-equipped engine is experiencing detonation, among them are reading the spark plugs, listening for pinging, and using the NOx reading from a 5-gas exhaust analyzer. The proper tuning of the ignition spark advance is one of the most ignored, yet the lowest-cost tuning tricks you can use to get maximum performance from your engine.

SYSTEM DIAGNOSTICS

A diagnostic scan tool such as the MAC Tools MDT10 can be used to determine if and by how much the knock sensor system is retarding the spark advance in order to avoid spark knock/detonation when the engine is under load. You could then fill the gas tank with a higher-octane gasoline to see if the knock reading on the scan tool is still present when the vehicle is driven under load. If 93 octane gasoline is not sold in your area, you may be able to purchase some 100 octane unleaded fuel from a performance gasoline supplier. Then you can see if the there is still a spark knock-detonation issue and find out how the engine performs with high octane gasoline. The MDT10 or equivalent scan tool can allow you to read and record the spark advance, rpm, vacuum (vacuum and boost pressure on a turbocharged or supercharged application), throttle position, and any knock sensor signal present during various operating conditions.



The man hours spent in the dyno room programing the PCM for maximum power and reliability translate into winning races. The air induction system used when the engine is on the dyno allows the operator to match the air temperature, pressure, and density to what the engine will see during actual race conditions.

MODERN GASOLINE

The base blend of each brand of service-station gasoline is basically the same, but each brand will mix in its own specific additive package designed to reduce combustion chamber deposits, and clean the injectors and intake valves. The gasoline is also blended for the season of the year, thus the winter and summer blends. Plus, there are quite a few areas of the country that require special cleaner-burning gasoline. There is also a push to increase the use of ethanol or other alcohol-based additives to both reduce fuel-related emissions and lessen our dependence on foreign oil. So, the gasoline sold in many parts of the country will contain up to 10% ethanol. This means that the blend of gasoline you use will not only vary from brand to brand, but also will change by the season and the location.

PERFORMANCE FROM GASOLINE

If the price per gallon were not an issue, a custom fuel blender could sell you gasoline that would help an engine produce

The location of the air cleaner above the headers will cause intake air temperatures to be very high, resulting in a wide variety of performance and drivability problems as the PCM attempts to adjust for the hot air.

A dial-back timing light can be used to read the spark advance curve of a conventional ignition system.

maximum power or the lowest possible exhaust emissions. Of course, it would be a lot more expensive than what you buy at your local gas station. Gasoline can be blended to match the needs of a high-performance engine whether supercharged, turbocharged, high-compression, nitrous oxide-injected, or one that's operated at very high rpm.

An MSD distributor includes an assortment of bushings and springs that can be used to change the rate and limits of spark advance.

The MAC MDT10 scan tool is our favorite for working on a modern fuel-injected vehicle.

There are several race fuel suppliers/ blenders that offer street-legal 100 octane unleaded gasoline that fits the needs of almost any vintage muscle car engine, or modern fuel injected high-performance engine. The 100 octane unleaded fuel option also is more stable as it is blended from a better grade of hydrocarbons, which means that it will not age/degrade as quickly as pump gasoline, which is especially important with race cars that may not be fired up for long periods. Also, the formulation (including the ethanol content) will be more consistent than commercial pump gasoline.

ETHANOL CONTENT

If the gasoline in your part of the country contains ethanol, fuel efficiency will decrease. That's because gasoline has more energy per gallon than ethanol – roughly twice as many Btus. Thus, alcohol-based fuels require a richer air/fuel ratio than pure gasoline.

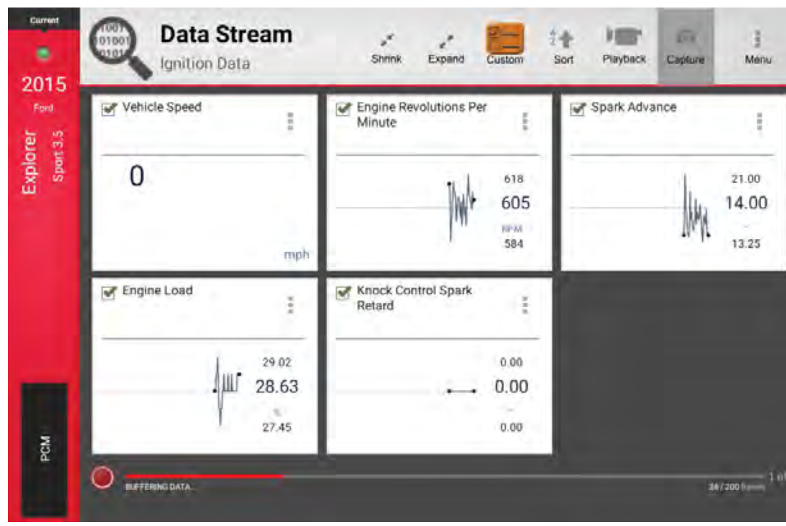
The ethanol is added to the gasoline as it is loaded into the delivery tanker truck, and mixing occurs through a process known as "stop light blending." This assumes that the ethanol will mix thoroughly with the gasoline as the tanker truck stops and starts on its way to the gas station to deliver its load, but sometimes this isn't very complete – some portions of the fuel may have a higher ethanol content than other portions in the same tanker load. If you happen to buy a tankful of ethanol-heavy gasoline, you may experience both engine performance and drivability problems, and even hard-starting in cold weather.

VOLATILITY

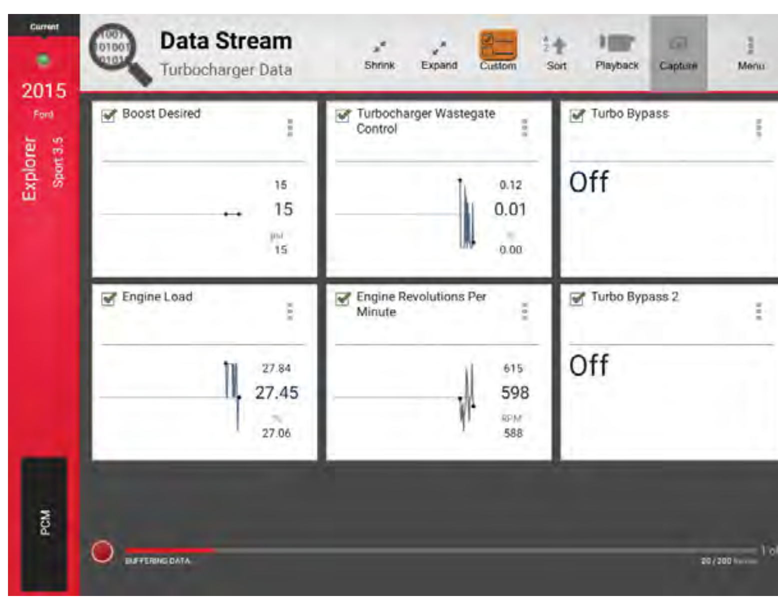
Reid vapor pressure is basically a measurement of the volatility of the gasoline. This measurement indicates how easily the engine is able convert the liquid gasoline into vaporized gasoline. The lighter or more volatile portions of the fuel are important when first starting an engine, so winter gas is blended with a higher RVP than summer gas. For example, in southern California summer grade gasoline has low volatility to avoid vapor lock, while the winter grade sold in Michigan would have high volatility in order to make starting easier in sub-zero temperatures. A fuel with a Reid Vapor Pressure above 8 to 10 lbs. could cause drivability and vapor lock problems, especially on a carbureted vehicle during hot weather.

The distillation/vaporization curve of today's reformulated gasoline has been changed to make it burn cleaner. Some of the lighter/more-volatile portions have been removed in order to reduce evaporative emissions, and some of the heavier/less-volatile portions have also been eliminated to reduce exhaust emissions. So, these new blends have a higher content of fuel that vaporizes in the middle temperature range and are therefore somewhat harder to light off, but are somewhat faster burning than the leaded gasoline of the 1960s and 1970s.

The formulation changes that affect how an engine will perform are the density of the fuel (specific gravity), the percentage ethanol content (if used), and the front end volatility. Each of these factors can vary as the formulation of the fuel is blended to conform to local environmental regulations, the season of the year, and how well the ethanol (if used) was blended with the gasoline. The front end volatility can be



The ignition system data from the MDT10 can show you spark advance, engine load, rpm, knock control spark retard, and vehicle speed.



This screen shot shows the turbocharger data stream of a Ford 3.5L EcoBoost engine.

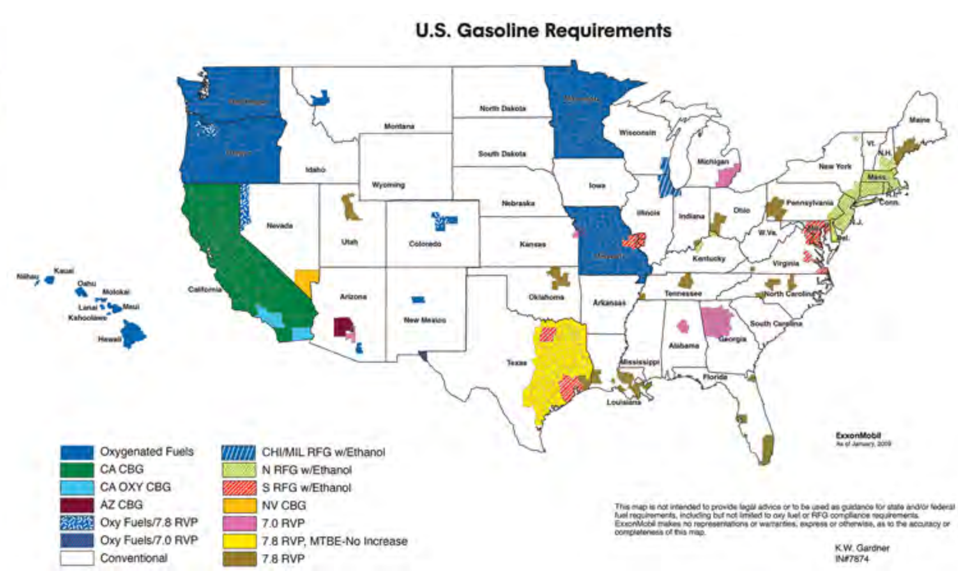
measured in the field with a Reid vapor pressure tester, but in a laboratory it is measured via an API - D86 Distillation Curve test.

DENSITY OF GASOLINE

The measurement of the density of gasoline is referred to as the specific gravity. When the density/specific gravity of the fuel changes, it will alter the air/fuel ratio you would get from a carburetor because the actual amount of gasoline flowing through the jets will be different. The density can also change the fuel level in a carburetor's bowl because the float will sit higher in a denser fuel. The rule of thumb is that if you're moving from a higher specific gravity to a lower specific gravity, you'll need to adjust the air/fuel mixture richer by going to larger jets, and vice versa. This may seem counter-intuitive, but the lighter specific gravity gasoline will lift more readily and in increased volume in the emulsion wells and out through the emulsion boosters thereby richening the mixture. The opposite occurs with higher density, heavier specific gravity gasolines. Race fuel companies such as ERC, Rockett, or VP can supply you with the SG measurement of the gasoline they sell.

RAISING THE OCTANE

The most common component used in the octane-enhancing additives on the market is manganese/MMT (Methyl Cyclopentadienyl Manganese Tricarbonyl), which is an effective octane improver at very low concentrations. When used at the recommended treat rate, you can gain a maximum of two octane numbers, but if you exceed the recommended treat rate it can foul the spark plugs and cause a build-up



Above: This map indicates the various areas that mandate cleaner-burning fuel blends.

Left: 100-octane unleaded gasoline can allow a high-performance engine to perform at its best.

of rust-colored deposits in the combustion chambers. The use of too much MMT can also cause an increase in exhaust emissions, plus it can foul oxygen sensors and the catalytic converters. You also may want to know that it is illegal to use MMT in commercial gasoline on public roads in some states, including California.

Driven Racing Oil Defender + Booster Fuel Additive is a product that uses MMT to raise the octane of unleaded gasoline. The company also advertises that it reduces valve seat wear and has corrosion inhibitors that help reduce combustion chamber and intake valve deposits. Each 10-ounce bottle treats up to 25 gallons of gasoline.

Lead — Tetraethyl Lead, or TEL — is known to be a very effective octane improver used in many racing gasolines and aviation gasoline. It is extremely toxic in its pure form, and is illegal to use in any street-driven vehicle in the U.S. since Jan. 1st, 1996. Lead will poison oxygen sensors and catalytic, plus if you were to add lead to unleaded gasoline it is not possible to calculate the octane number of the final blend.

THE 100-OCTANE OPTION

The 87, 89, 91, 92, or 93 octane that you buy at the local service station is a good gasoline for satisfying the government's requirements for improved fuel economy and reduced exhaust emissions. The use of octane boosters in street gasoline is not always the best way to increase the octane rating. An alternate solution is to use a

There is a wide variety of performance and race fuel blends that can match the needs of almost any high-performance or race engine.

This fuel tank is used in making custom blends of performance gasoline.

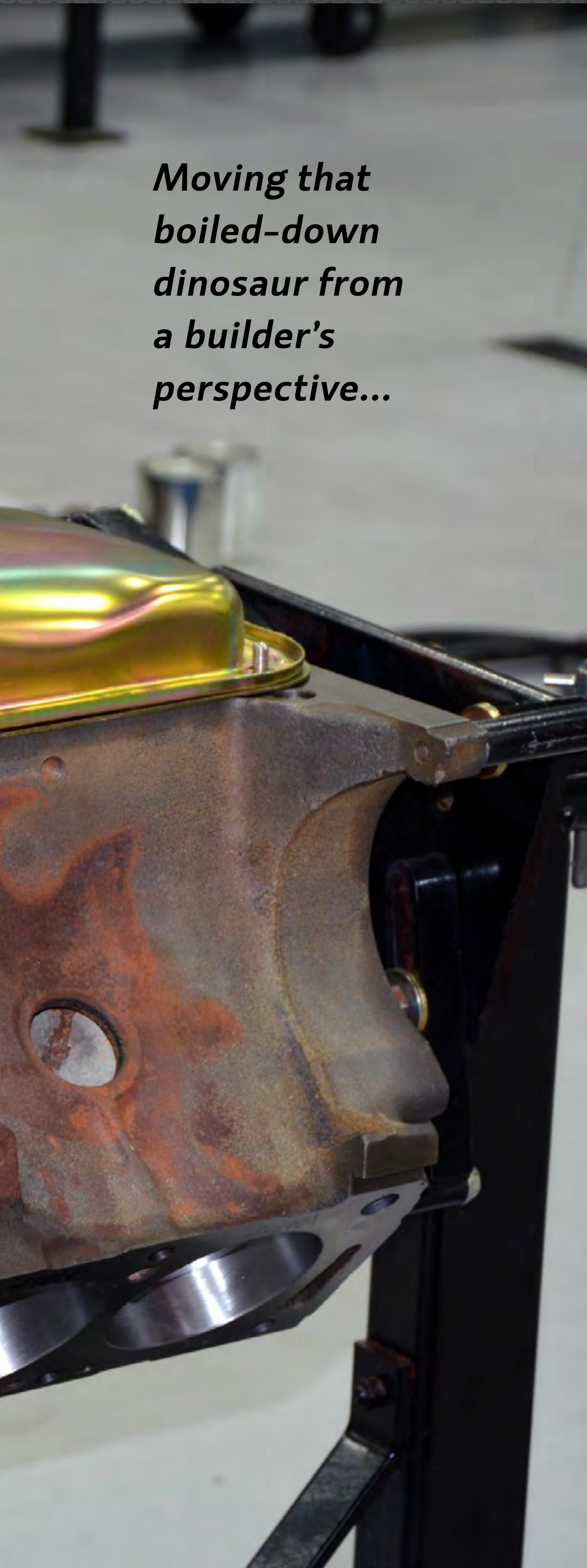
100-octane performance gasoline such as Rockett Brand 100 Octane Unleaded. This Rockett product is street-legal, and can either be used in its pure form, or blended with any street gasoline to get the level of octane your engine needs. You will always know what octane you end up with because Rockett provides you with blending charts. Visit www.rockettbrand.com.

In addition, if the 100 octane gasoline is used in its pure form, the engine will make additional power due to its "improved burn" characteristics. This is because Rockett Brand 100 contains a very select group of hydrocarbons that vaporize and burn much more readily than those found in conventional street gasoline. When more of the gasoline is burned in the combustion chamber, the engine makes more horsepower because of improved combustion.

A good leaded racing gasoline is designed to burn efficiently between 5,000 and 9,000 rpm, while most unleaded commercial unleaded gasoline is designed to burn most efficiently from idle to 3,000 rpm, which is the highest speed most engines see during the EPA test for exhaust emissions. Mixing street gasoline with leaded racing gasoline compromises the good high-speed burn characteristics of the racing fuel, thereby reducing the potential engine output, and it also reduces the octane quality of the blend. ■

OIL PUMPS, DRIVES, PANS, AND PUMP SYSTEMS, PART 1

-Greg McConiga



If you race at any level, you spend a lot of time and money pursuing your hobby, something I'm sure we're all painfully aware of by now. Worse, if you race at or near the top of your class you spend more and more money for less and less return because the last few trick parts or processes it takes to get you there are the most expensive on a dollar-per-position, dollar-per-horsepower, or dollar-per-point basis.

While the glamor parts like cylinder heads, camshafts, valve control systems, intake, headers, and fuel delivery get all the glory, none of it is worth any more than current scrap price without a well-designed and reliably-functioning oiling system because without it all those parts just become something to drive over when the engine scatters.

Oil itself is big science these days. It provides lubrication and cooling, it contains detergents to clean and surfactants to hold contaminants in suspension until they can be filtered out, and it provides corrosion protection for every internal engine piece.

Left: Once I check it by measurement, I double-check it just before I install the pan with clay. The best way I've found to do this without making a mess of things is to work the clay in my hands until it's nice and warm and soft and then wrap it in a double or triple layer of cling wrap so it can't extrude into the screen or stick to anything. I lay it on top of the pickup, bolt the pan down with a few fasteners, pull the pan and section the clay with a razor blade and check my distances.

The right oil with the right viscosity at the right temperature delivered with the correct pressure and in sufficient volume combats metal-to-metal contact, scuff and gall, flows easily when cold or warm and absorbs and dissipates as much as 15% of the waste heat generated by your engine.

FAST DRAIN & FILL

Which oil you use, what weight and what type are topics for another time, but whatever oil you use you have to concentrate it in sufficient volume to feed the oil pump suction side without inducing air or cavitation, pull it into a pump, pump it through the oil distribution galleries or hoses, get it back into the oil pan, and gather it up again for another circuit through the engine, all at volumes varying between roughly two gallons per minute at idle and over twelve gallons per minute at redline. Think about that for a second. The pan is being emptied and refilled at a rate of over five times per minute — as often as once every seven or eight seconds in the worst case scenario for a six-quart system! In the meantime, we're dealing with blow-by at high engine speeds as the rings become less stable, a violent, shifting pumping of the crankcase caused by the pistons bobbing up and down on alternate banks, oil that is caught up on the crankshaft and entrained with air, and the whole mass looks like a giant taffy pulling machine like you used to see at the state

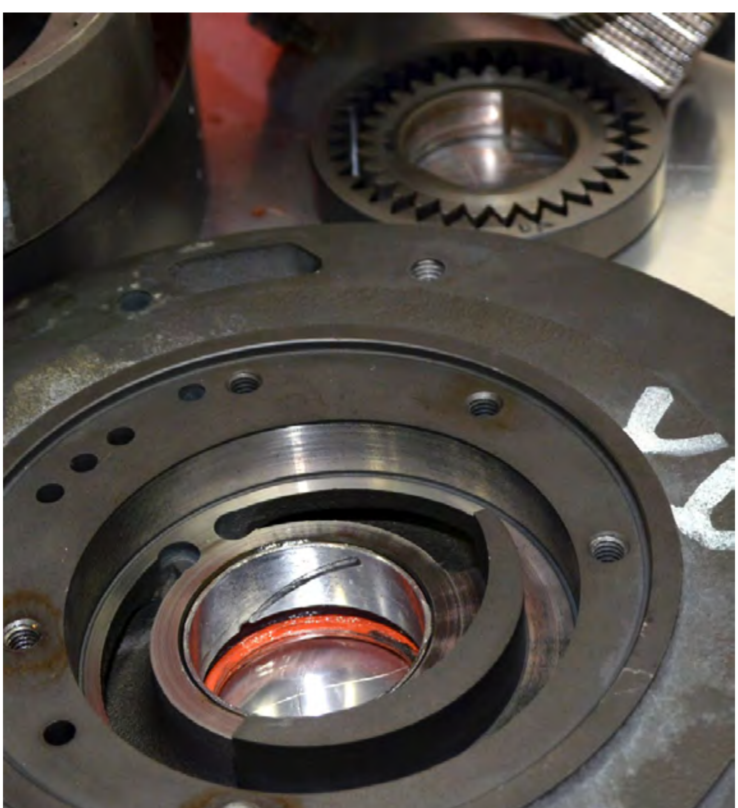
The pumping elements of a positive displacement oil pump come in a number of configurations. I dug around the shop and came up with these examples for you, but I'm sure that as technology has continued its onward march there are others out there.

The spur gear pump has a couple of advantages in that it can make a lot of pressure and volume and it can handle a good bit of wear material and swarf. Not every design likes wear material moving through it and a gerotor pump will lock up and twist off the drive rod if it's forced to chew up a lot of wear shrapnel. Increasing the overall length of the gears and deepening the housing makes the move from standard-volume to high-volume. Gear pumps tend to generate a busy pulsing flow that steadies up with increased drive speed, something you can easily detect if you prime an engine equipped with one. You can feel the rolling gears in your hand through the drill.

fair. (Go to https://www.youtube.com/watch?v=B0Ls3MFeJv0 in case you forgot what that looks like!) This next link shows a quick simulation of engine oil splash and crankshaft interaction: https://www.youtube.com/watch?v=24AbjTx5x7E.

Watch simulation of engine oil splash and crankshaft interaction.

In addition to all that havoc, you're dealing with the results of an oil pump drive attached to the other end of your distributor (maker of sparks and keeper of timing), which is subject to surging, pulsing loads caused by changing rpm, and the oil pressure relief valve opening and closing tossing your spark control out of whack. What you end up with is another excitation force applied to the camshaft, valve train and timing drive system, often imparted at the camshaft end opposite the primary source of cam excitation originating at the crankshaft driving the cam as each cylinder-firing event accelerates the crank and, through the drive system, the cam. Designs that have the distributor at the front



The crescent and internal gear pump has been the primary fluid mover in automatic transmissions for many years. This example is from a Ford C-6 transmission, but it's nearly identical to any pump of this configuration used as the oil pump in later model engines where the pump is driven from the crank nose at engine speed. The main strengths of this type of pump is that the pulsing rate and volume are high enough that it provides a very clean hydraulic signal wherever it's used and it can easily develop the extremely high pressures typically required for transmission operation (but not necessary in an engine). It's quite robust and can handle contamination fairly well without locking up. Increasing the volume capacity is as simple as increasing the depth of the pump pocket along with the drive and driven members. Of course, you could also increase the diameter if the available space allows. It's well-balanced with large suction and discharge cavities that end up opposed to one another, but with the added support of the fixed crescent and the large diameter center of the drive gear, which is mounted to either the torque converter (in this case) or the crank nose.

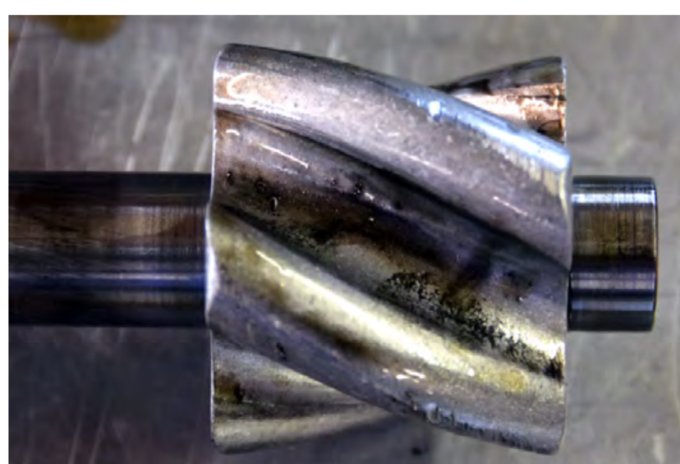
of the engine suffer less, but any time you apply multiple forces from different sources to a single component the chances of hitting destructive sympathetic or resonant frequencies increases. Are we having fun yet? We ARE having fun, right?

TWO VARIETIES

Oil systems come in two variants, wet sump and dry sump. A wet sump system is most common and the one used for generations of street-driven vehicles of all types since the earliest days of the automobile. A small-capacity storage area is created in the oil pan, which is shaped to provide a reservoir for oil, and an engine-driven pump is either submerged in the oil or connected to the oil in the pan through a pickup pipe located within three-eighths to a half inch of the floor of the deepest part of the pan. Wet sump systems and wet sump oil pumps work quite well in low-power or steady-state or stationary applications, but their inherent weaknesses begin to manifest themselves as power output increases, the operating range widens, the engine is operated continuously between closed throttle and wide open throttle (you know, like racing...), or if the vehicle is exposed to extreme G-forces during cornering or acceleration.

The twisted lobe gear shown is from a Peterson dry sump R4 pump and it's a fairly new design. It's a variation of a lobed pump, like that found in a straight rotor Roots blower or in some industrial high pressure fluid movers. The main advantage to a lobed pump is that it has a very high capacity to handle garbage. In fact, lobe pumps are often used as trash pumps or to move things like foods, such as cherries or grapes with minimal damage, obviously sized and operated at speeds compatible with such delicacies. For an oil pump application, the large volume of the rotor allows most damaging material to move around the through the cavity without causing catastrophic damage, although it's not uncommon for the lobe face to become scarred enough over time to require replacement. As long as the tolerance between the lobe face and the housing it lives in is good, it'll make good pressure and volume.

The nice part of the dry sump system is that it's all rebuildable and it's external to the engine, so if something develops mid-season a couple of bolts, a half dozen hoses and removing the drive belt is enough to land it on your workbench for repairs. The other good part is that there's a selection of drive and driven pulleys available in different tooth counts and should it be needed you can speed the pump up temporarily to get you through until you can get back to home base and get it fixed. Of course, if your problem is sudden and extreme, smart money says shut it off and conduct full engine forensics, because increasing pump speed in that case is like putting a Band-aid on a bullet hole and what happens next will not be good.



A dry sump system is exactly what it sounds like. The pan is as flat as it can be and still provide clearance for the parts moving inside it and the necessary kick-out needed to catch oil, with no internal engine storage capacity. The pan remains largely dry other than for whatever liquid lube is moving through it as it collects the oil leaving the lubricated parts, which is then quickly pulled from the pan by one or more scavenging pump sections plumbed into the side of the pan. Oil storage in a dry sump-equipped vehicle is accomplished by using a remotely located tank plumbed to and from the engine by properly designed and sized hoses.

There are surprisingly few factory-installed dry sump oiling systems out there, due in part to what has to be a corporate cost versus benefit analysis, and in part because they are more complicated and not really needed at the performance levels most commercial road cars can attain. The few that exist are confined to some of the exotic Europeans like Porsche and Ferrari, although a hybrid dry sump shows up on a few LS engines and Corvettes. If this latest performance and horsepower race continues another few years, I'm sure we'll see more of them appearing on our road cars.

The gerotor pump shown is a Titan billet pump that we ran a few seasons and it's a good example of the breed. Gerotor pumps are efficient and smooth mechanically, but they suffer from some hydraulic noise because the pumping elements are located off center and they generate uneven pressure loads that can make them vibrate and shake the drive system. Increasing volume is as simple as increasing the drive and driven element length, but they don't like to digest things that aren't oil.

If you roll a gerotor pump through, you'll see that the end of the rotor passes very close to the ring and any little bit of crud that gets into the pump can (not necessarily will, but can) lock it up. Over the years, of all the pumps t I've found locked, this type probably accounts for 90% . Now, you could ask, "If it's got that much junk passing through it, don't you have bigger problems?" Of course, the answer is yes. I'd just prefer that my oil pump not be the "fuse" to detect and protect the developing engine problem! I'd prefer to catch it by inspecting the oil filter or with a driver who's situationally aware, but I understand that in the heat of the race that's not really what he's thinking about or focused on.

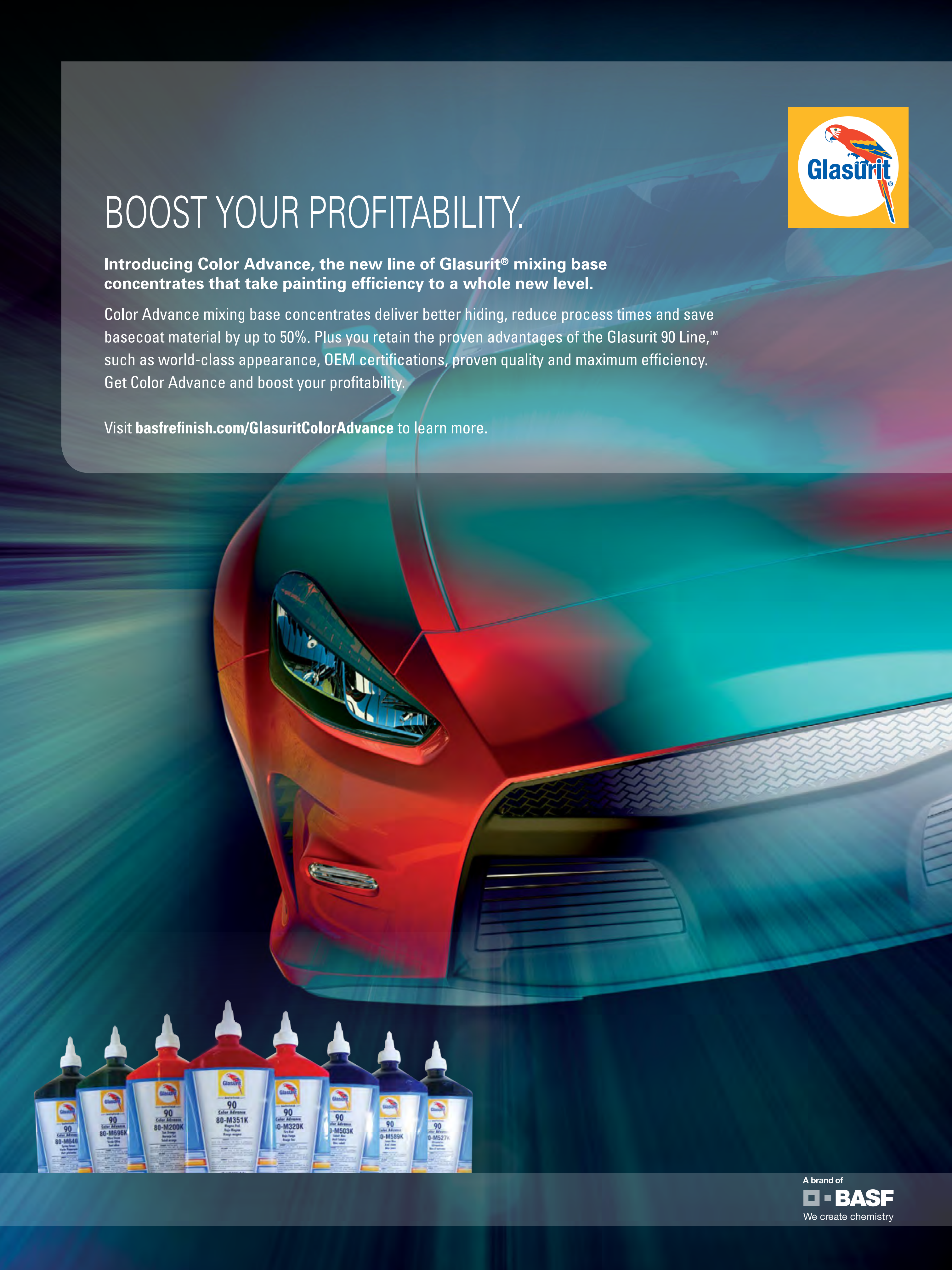
TOO TALL

For racing, one of the big disadvantages of a wet sump is that it requires a fair bit of vertical real estate to locate it in the engine bay. Because it relies on gravity to refill the pan, its location on the bottom of the assembly is fixed and limits how low in the chassis the engine can sit. The combination of a deep sump (to increase capacity, move the oil away from the crank, and increase the oil level over the pickup) and a low chassis height means you get the chance to knock the oil pan open at speed — a real exciting deal if you do it right (say, hitting a lonely piece of bent rebar on the highway and oiling down the drive tires — don't ask me how I know that).

A wet sump is prone to cavitation on the suction side and to uncovering the suction in high G force maneuvers – a three-G force on the car will stand the oil level up at a nearly 75 deg. angle in the pan, uncovering the pickup in all but the highest capacity systems. This condition can only be partially resolved with increased depth and a robust oil pan design full of dams and trap doors. Wet sump engines are also subject to high levels of power loss due to windage and have a higher potential for failure caused by air entrainment because the oil is held in close proximity to the reciprocating assembly where it can be picked back up by the wildly swinging crankpins and rod ends and re-thrown as it ricochets around the pan, or made to stand up and get pushed up into the crank on acceleration or deceleration or on hard cornering as the oil rolls up the pan wall. As a result, the oil never has time to de-aerate and it becomes an air-oil emulsion that is not optimum for lubrication or cooling — two of its most important jobs inside the engine. If the rules require it and a wet sump system is all you've got, then we need to take a hard look at all the things you can do to keep your engine alive with it.

For a serious drag race car or high-performance road-racing application, a wet sump is not the best choice in my opinion. It's like playing with rattlesnakes: The question isn't IF you'll get bitten, but when.

One measurement that should always be performed is the pan floor-to-oil pump suction distance. There are a couple of ways of doing this, and I generally do both: a physical measurement with a square and straight edge, and a double check with clay.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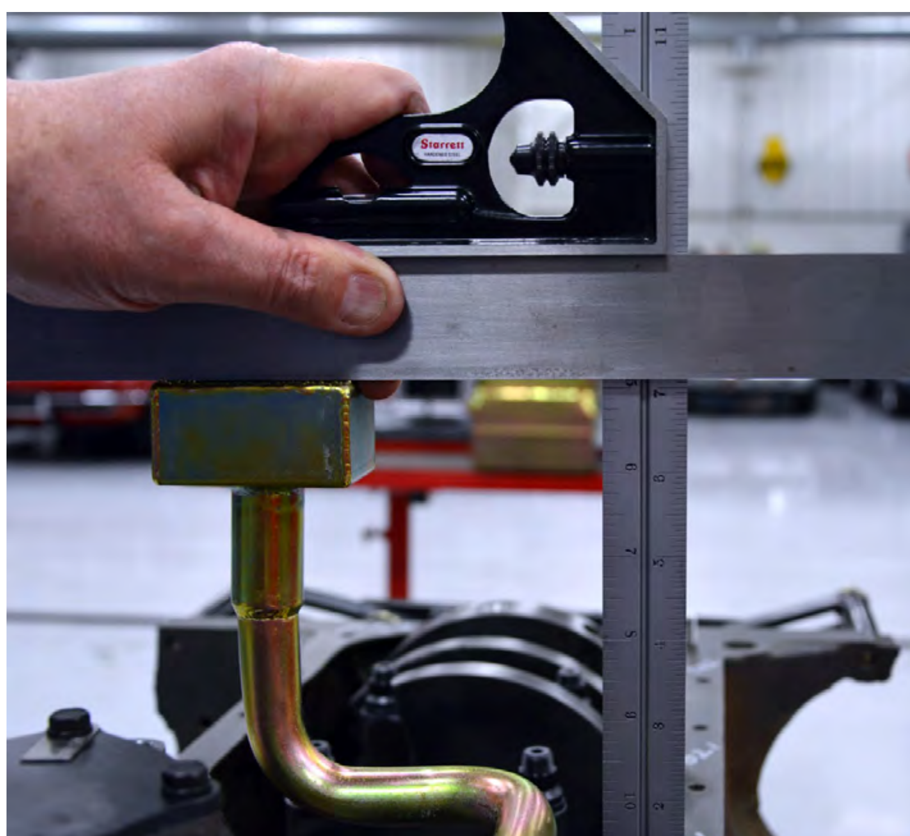
You can make them work — no question about it — but not without considerable time, oversight, and careful technique, and you'll need a heavyweight wet sump expert like Schumann's in your corner (see accompanying story). Let's see what's out there and let's look at what you need to make your wet sump as good as it can get.

SPINNING IT VIA THE DISTRIBUTOR

The first order of business is the drive end of the pump, which for most V8s is located at the opposite end of the distributor, driven by the distributor drive gear via the camshaft. Thankfully, the newest generations of engines have long since lost the distributor and the oil pump drives associated with them and are driving the oil pump directly off the crankshaft, either at the nose or from a chain or gear arrangement. This is far more desirable in that it increases pump speed and the mass of the entire reciprocating assembly now driving it is better able to absorb any hydraulic loading variations.

For now, let's just talk about wet sump, distributor-driven oil pumps. To begin with, it's not uncommon to adjust combustion chamber volume by milling the heads, and doing so lowers the distributor in the block. So, the first order of business is adjusting distributor depth to accommodate any change in installed depth caused by altering overall head/intake mounting heights. This is particularly important to check if you're not the first builder, or if you're freshening up an older engine that's been in service for many seasons. Before we jump into this, let's talk about distributor drive gears because there's no point in

The maximum distance you expect here is a half an inch — 3/8 inch is perfect and a quarter inch is cutting it just a bit too close, particularly on a steel pan with little or no strengthening beads rolled into the floor sheet metal. Can you get away with a quarter inch? Probably (maybe?), but I'd probably weld legs onto the pickup to physically hold it off the pan just to be sure it didn't pull the floor up into the suction and shut off the flow. I'd say a quarter inch will work with an aluminum pan, which is made of heavier material and stiffer, but with a steel pan I'd be nervous.



continuing until we have the right gear made of the correct materials mounted on the distributor.

GEAR MATERIALS

Cams come in cast iron, ductile iron and steel, and some steel cams are now supplied with pressed-on iron cam-drive gears as an option. One of the big issues with driving an oil pump with the distributor is the loading on the gears. The cam and distributor gear are both relatively small, and high-viscosity engine oils impart quite a load on these gears, particularly when cold, which can result in high rates of gear wear or failure. If you end up using a bronze distributor gear, it's not uncommon to replace them once a year due to wear, and that's one reason I'm not a fan of them. Where's does that material end up? What does it do to the bearings on the way to the filter? It's the same reason I dress the ends of the valve springs — that sharp tang rotating on the seat and on the retainer is grinding off fine particles that circulate throughout the engine and I like avoiding that whenever I can.

There might be a few non-believers out there, so I included a photo of a restoration engine that came in with no oil pressure — a 427 tri-power big block Chevy is not a good candidate for low oil pressure, much less NO oil pressure! The pickup was right on the deck and the pan got a bit of a dent, and guess what? You can see the witness mark in the pan floor where the pickup ran hard aground and basically sealed off the oil pump suction. Fortunately, there was no engine damage and she lives to roam the streets again, terrorizing children and little old ladies alike.

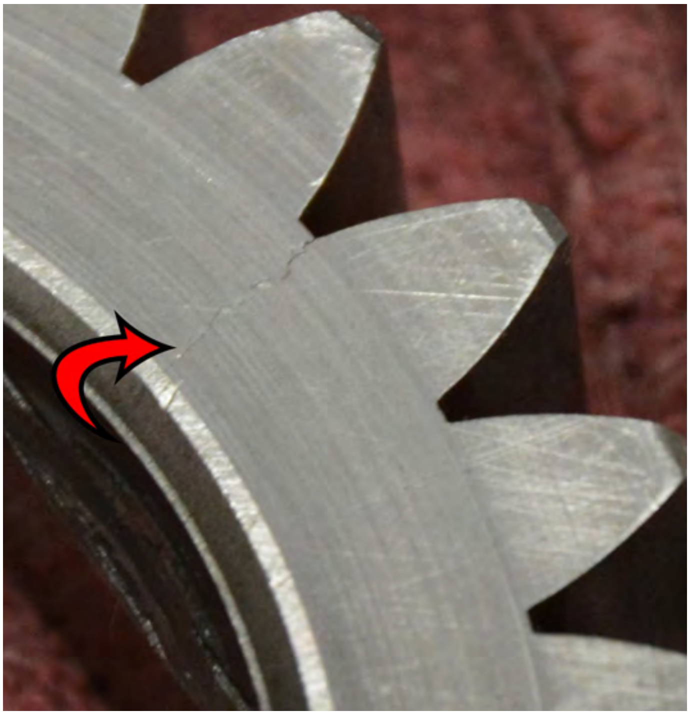
If you've ever hand-primed a cold engine with an electric drill you know just how much force you have to counter once the pressure comes up. If you let go of the drill it'll wind up and smack you stupid on the next trip around. Which brings up an important point: On most engines, no provision is made to pressure lubricate the distributor drive. Where you can, when you can, if an oil gallery or gallery plug is nearby, it's a good practice to drill a .020 in. hole in it to spray the gear interface with oil, particularly if you're running high-volume or high-pressure pumps. This keeps gear wear to a minimum and wear swarf out of your engine. Once damaged, the cam can only be replaced, unless it's equipped with a press-on gear, but that still requires that the cam be removed and shipped off for repair.

There are four materials available for use on the distributor through several sources: the stock cast iron gears, aluminum-bronze gears, Melonized steel gears, and composite gears. Each material has its application, with cast iron reserved for stock or near-stock use and only on cast or ductile iron cams. Bronze gears are compatible with steel cams, but not with cast iron or ductile iron cams. While bronze may work for a while on cast or ductile iron, service life will be shortened. Composite gears (made of carbon-poly materials) work on any cam material, but are not the best choice for high-volume or high-pressure pump drives. In fact, they are specifically not recommended for those applications by some manufacturers. Melonized steel gears are approved for use on all cam materials and are the first choice for most applications where high-volume and high-pressure pumps are used. I've been using them exclusively for some time with no failures to date, but some builders report that they've had some early issues with wear. There are some billet steel applications that recommend bronze gears for use with high-volume high-pressure pump drives, so always consult with your cam grinder and get his or her recommendations — never be afraid to ask the question if you're uncertain. It's always better to ask what someone might think is a dumb question than it is to make a dumb mistake that could cost thousands in damages. Ego is a damn poor reason to not do your due diligence.

You'd think that a subsystem that runs completely submerged and surrounded by oil would pretty much be failure proof, wouldn't you? Sadly, this is hardly the case. Here are a couple of examples of things to think about. The rotor shows you what happens if you don't change out your engine oil before wintering over. Combustion byproducts are corrosive and over time they produce this rusty pitting on everything, including cylinder walls, camshafts, oil pump members and most internal engine surfaces. If you don't routinely take your engine apart over the winter to freshen it up, at least bring the engine up to full operating temperature and drain the crankcase and filter and put fresh oil in for the winter. It helps to "pickle" the engine with outboard engine fogging oil as well as pulling the plugs and leaving them out for the winter. Resist the urge to go out and start it up… just put it to bed and come spring pre-oil it just like a fresh build, start it up and prep it for the season ahead.

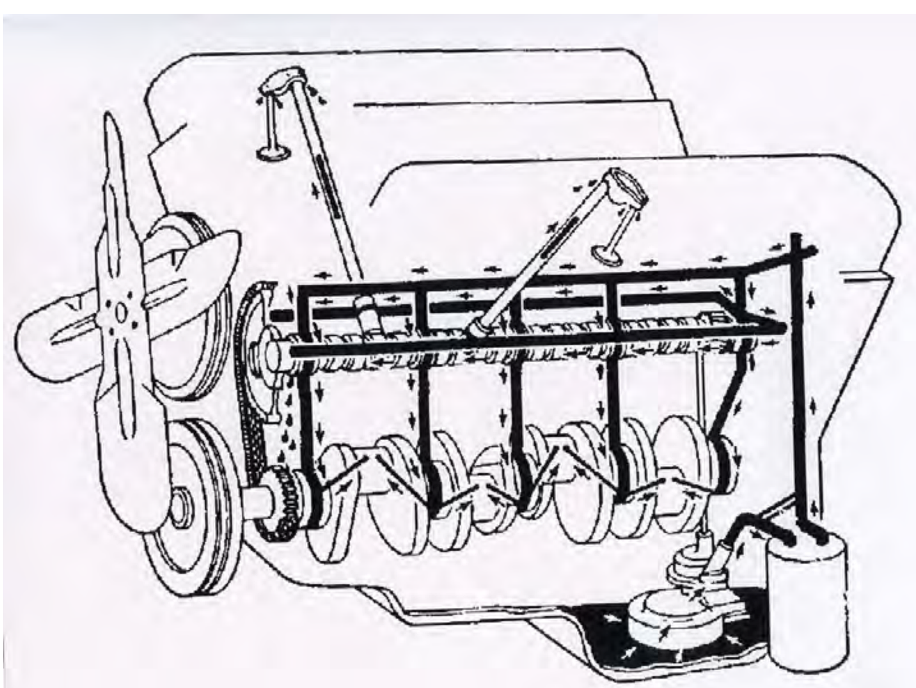
HOW DEEP?

To get distributor depth right on engines that are modified for racing, distributor



The cracked drive gear is a pretty unique failure — it's the only one I've ever seen. I don't know what went through this pump to cause this break, and there really wasn't any tell-tale on the pump elements, so I'm guessing this is just a fatigue failure caused by a manufacturing flaw.

makers offer units with adjustable stop collars so that you can set the installed depth to your application. The three critical measurements to check are the drive gear engagement, backlash, and the oil pump drive rod engagement depth. Using a marking compound of your choice, and while applying counter pressure to the distributor shaft by holding onto the rotor, rotate the cam, remove the distributor and read the marking pattern. The drive pattern should be centered on the gear vertically and you should have a few thousandths of an inch of backlash. You should have some vertical movement in the oil pump drive shaft as well; it can't be locked up between the distributor and the pump input without doing damage. A good starting point is about .030 in. vertical movement, followed up by reading the gear pattern. It's the pattern that's most important to set first; you can always change, grind, or modify the



For every engine there's an oiling map. It's a circuit through which oil is delivered to the various parts needing it. In stock-block applications, that map is rarely the first thing the engineer designing the block thinks of, and the location or efficiency of how the oil is delivered to the most highly-loaded components is an afterthought. I suggest that you physically check and map every engine you build so you know where the oil goes and how it gets there and what detours it takes before reaching the crankshaft. Remember that every component it passes before it gets to the crank is a leak, and that pressure and volume are dropping all along the way.

oil pump drive rod to get the end play you need between the distributor and the oil pump. Driving the distributor takes nothing, but spinning the oil pump can require considerable effort, and the hydraulic load can be severe enough under certain conditions to introduce timing chain upset, so get those gears centered and keep your backlash on the tight side of spec to minimize whip and scatter.

If you don't have an adjustable drive collar and need to move the distributor up simply cut shims from nylon sheet and install them under the distributor mounting flange as needed to move the distributor up. Moroso actually makes shims for Chevy engines and there may be others for different makes out there that I'm unaware of, but you can make them in-house with a gasket cutter set and nylon sheet available through any of the industrial supply houses.

The next thing to look at is the depth of engagement between the pump input and the drive shaft that connects the distributor to the drive rod. The oil pump intermediate drive rod should be as large as you can get into the allowable space and made of the best materials available. ARP, Moroso, Manley, Crane, and many other companies offer a variety of extreme-duty oil pump drives. Again, block-mounted distributors like those found on many engines such as some Fords and early Mopars won't have the dimensional variability created by manifold-mounted distributors and cylinder head modifications, but it's good practice in every case to install and fully tighten the distributor and check to see that there's some end play on the oil pump drive. It doesn't have to be a lot — anything around .010-.050 in. is fine — it just can't be bound up. Measure the drive rod engagement depth and make sure you've got as much as you can get on both ends so that the load is distributed over as much area as possible. There are directions on measuring oil pump driveshaft engagement or overlap at MSD, but the short version is that you measure from the mounting collar to the end of the distributor drive and from the manifold mounting surface to the top of the intermediate drive rod, and subtract the two dimensions. More is better!

Now that the wet sump pump drive is sorted out, we can start to look at oil pumps, pans, scrapers, oil control systems, vacuum systems, and other assorted bits.

Stay tuned, there's more to come! ■

Racing engine blocks are specifically designed to deliver oil to the most heavily-loaded parts first, which are the main and rod bearings. Study your application and decide if and where you can restrict oil feeds that rob volume and pressure from your reciprocating assembly, particularly if you are building a lot of power in a stock-block application. Every stocker has weak spots, so do a bit of research and find out where those weak spots are and see if anyone is making parts overcome those inherent design flaws. (Courtesy Dart Machinery.)

Engine and Transmission Repair Stand by Werner Weitner

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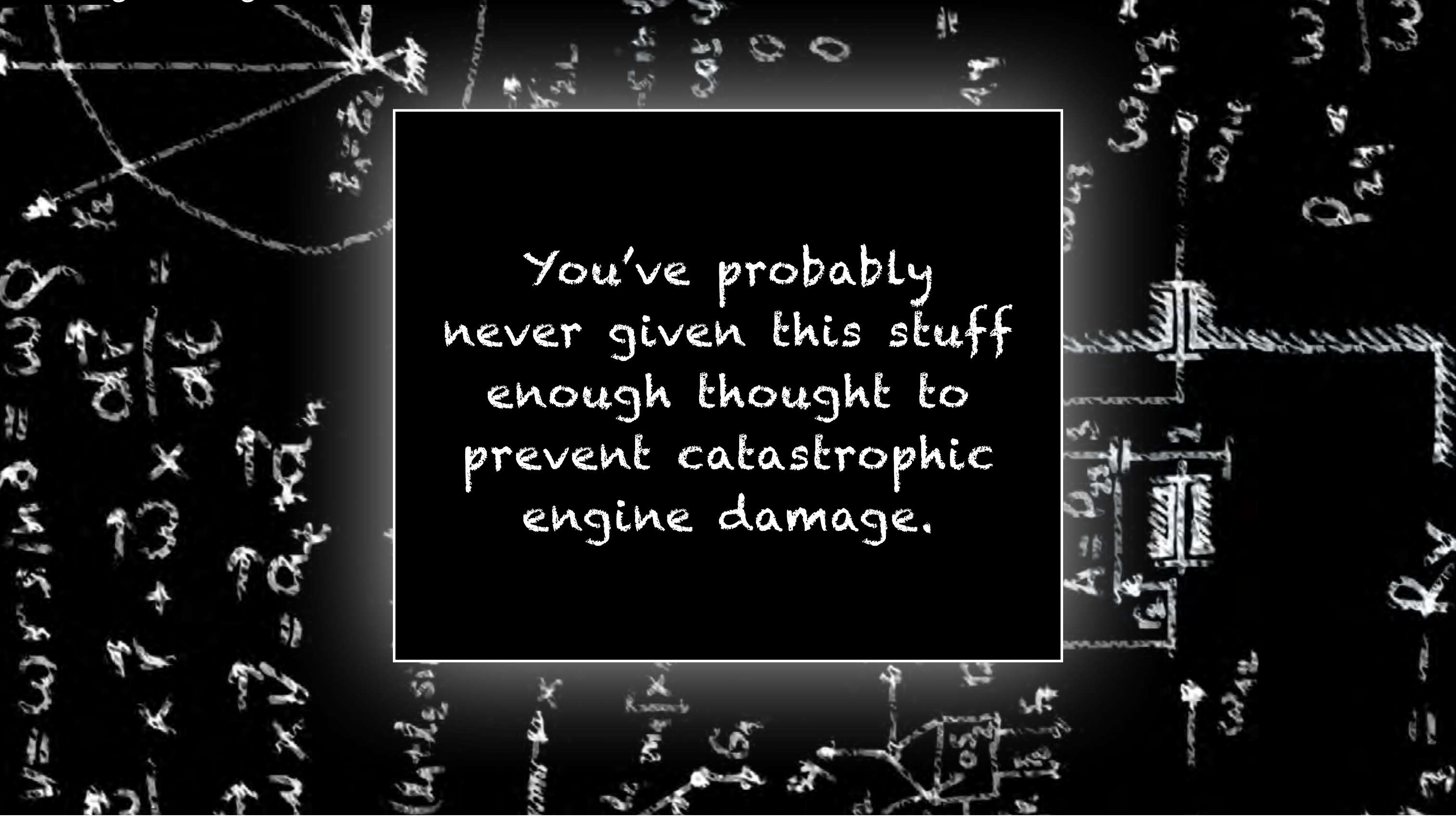
THE PHYSICS OF LUBRICATION SYSTEMS

-Greg McConiga



Engine lubrication: We love it when it's good to us and hate it when it lets us down. It keeps our parts alive, breaks our little monsters into thousands of pieces, makes us winners or losers, and it falls into the category of Big Science while being a little vague and hard to wrap heads and hands around.

VOLUME AND PRESSURE

Let's start with this: It's all about the volume (gallons per minute) of what we pump, and the composition or quality what we're pumping (we'd like to have pure, unaerated oil, if we could get it).

We shouldn't care as much about pressure (pounds per square inch) as we've been taught, beyond having enough pressure to overcome resistance to flow without having so much that we waste power that could otherwise be used to propel the machine in building excess pressure. Pressure is simply the easiest measurement we have access to that tells us something about the volume of oil we're moving inside the engine.

The pressure we read is the result of the volume of oil being pumped into the various oil delivery channels of the engine and ultimately to the sliding, rolling, and wiping surfaces that require oil, and how much oil is leaked away at all the various bores and crevices. Every engine has a oiling map — a circuit through which the oil flows and is delivered to all those highly-loaded surfaces — and you should examine and map out those passages every time you build so you understand where the oil goes and in what order it's delivered throughout your engine. A good understanding of the oil map could uncover design flaws or areas where small improvements could have a dramatic positive effect on engine performance or longevity.

Oil pressure is the result of the volume of oil that's pumped and the sum of all the internal clearances (leaks) to which the oil is supplied. An oil pump doesn't know pressure from howling at the moon, and, in fact, if you just run it outside of an engine it simply supplies volume in gallons per minute in free flow, until such time as you begin to throttle back on the discharge. Then, and only then, does the pressure begin to build until the relief system comes into play, which then dumps volume back to the pan or recirculates volume internally from the discharge back into the suction side in an effort to match downstream oil volume demand with oil pump volume supply.

An oil pump has to be sized to provide sufficient flow at idle, when pump speed is lowest. Factory pumps are typically 40-50% larger than required because they are designed to provide enough capacity to make up for engine wear over many thousands of miles. Racing pumps can be sized according to application by increasing or decreasing the size of the pumping elements.

At speeds higher than idle, the pump supplies more volume than the engine requires, so the relief valve opens and dumps the excess volume. In doing so, it "sets" the peak oil pressure reading. Oil pumps are of the positive-displacement variety. What gets pulled in must be discharged (within reason; as pressure builds there is a small amount of slip that occurs inside the pump, but for all practical purposes what goes in must come out). A positive-displacement pump moves a fixed volume of oil with each rotation, and increasing the speed of rotation increases the output volume proportional to the speed. An engine oiling system requires roughly two gallons of oil per minute at idle and perhaps as much as 15 gallons per minute at maximum operating speed, and the point at which the volume output curve exceeds the volume demand curve is where the relief valve begins to operate, dumping excess volume, which shows up as a controlled maximum operating pressure. Think about it: Putting in a heavier spring or increasing the pressure setting just means that you delayed the relief valve opening, which just pushed more volume out into the same size restrictions of the engine. Pushing more volume through the same opening raises the pressure applied to the opening and changes the flow rate through each leak point because more pressure exerted across the same diameter hole will increase the flow rate through the hole. You can have too much flow. Flow rates that are too low won't put enough oil in the bearing to either lubricate or carry away heat, but high flow rates end up costing you in terms of pumping losses, windage, and aeration.

Here's why: A positive-displacement pump will make as much pressure as the power applied to it will allow, right up to the point where the pump or discharge piping fails. If you throttle the discharge on a positive-displacement pump, eventually you either exceed the power available to drive it, or you blow the pump housing and discharge piping to pieces.

So how much pressure do we need? Well, it depends! The standard of 10 pounds per square inch per 1000 rpm still applies for nearly all applications, unless you're moving up into Formula 1 or Top Fuel. There are a lot of urban legends about washing out the engine bearings with excess oil pressure, something I have never seen and cannot say with any certainty can occur. In fact, I'm willing to bet that it doesn't happen, and those who thought that's what they saw misinterpreted the results. I'd bet that it was some form of hydrodynamic cavitation at work in the bearing interface. If you look at the localized pressures exerted on an engine bearing, it measures in the tons per square inch! I find it hard to believe that high oil pressures, even as much as 200 psi, will add much at all to bearing erosion, particularly on a racing bearing with a thin and robust overlay. It will heat up the oil, increase flows rates and rob power, but I'd have to see the erosion damage to believe it. Call me a skeptic…

What we do know is that some engines require very high oil pressures to force the liquid lube into the heavily-loaded crank/bearing interface. Top Fuel, for example, runs pressures over 150 pounds per square inch, and F-1 engines are often in the 120-130 psi range, so the required or expected oil pressure an engine requires is specific to the application and possibly to the type and weight of lubricant that is used.

While we typically check oil pressure at the beginning of the oil map, somewhere close to the pump, in my opinion pressure should also be measured at or near the end of the oiling map if there's access if for no other reason than to provide a baseline reading for what the pressure drop across your new build looks like (which might provide you with a clue to overall engine health if you continue to check it periodically as the season progresses).

CAVITATION AND AERATION

There are two other effects we have to look at in a working engine oiling system: cavitation and aeration. Cavitation can occur in any liquid and the effects of unwanted cavitation are officially categorized as "not good.

A liquid can boil at any temperature if you reduce the pressure enough. We use this principle to remove moisture from the air conditioning system by pulling a deep vacuum, which results in any trapped water being boiled off, even at low ambient temperatures. Cavitation occurs when some disturbance or restriction or localized low-pressure area causes the liquid to fall below the boiling point on the pressure-temperature graph for the conditions of the fluid being pumped, and vapor bubbles form in the liquid. In the oiling system, it can be suction cavitation, caused by low pressure or the pressure drop on a sharp edge or orifice, or discharge cavitation, where the internal relief system bypasses at such a high rate that the oil temperature rises. At high internal flow rates, the small clearances of the pump act as a venturi and cavitation vapor is formed on the suction side and collapses on the pressure side, or hydrodynamic cavitation in crevice areas like the bearings.

Cavitation is bad because when the pressure rises above the vaporization point, the bubble collapses suddenly and violently, and in doing so emits a very high-pressure jet in the liquid that can literally tear away bits of the surroundings. Systems that have experienced cavitation are identified by pocked or sandblasted-appearing areas, typically on the edges of the pumping elements. The point of damage occurs at the point where the pressure rises again.

IS IT AIR OR IS IT OIL?

Aeration is an entirely different phenomenon that causes a different level of pain. It's the result of the oil and the air in the crankcase being whipped into a foamy emulsion that is neither air nor oil. If left unresolved, it can result in something other than oil being delivered to the engine bearings, with predictable results. Aeration adds to the problem of windage, which is power lost to moving the crankshaft and connecting rods through the contents of the crankcase.

Windage is what you feel as you swim — driving your hand into the water and pulling against the resistance of the liquid, which is why swimming is such good exercise. Adding air to the mix increases the volume of material exposed to the rotating elements, but windage loss is what occurs as the oil is slapped around by the crankshaft. Minimizing aeration and windage is something every racer battles. Crankshaft scrapers, hand-whittled to conform to the build, are used to knock the oil off the crankshaft as it passes within an 1/8 in. of the installed scraper. Screens of different designs mounted in the oil pan catch the oil thrown from the crank and prevent it from being reintroduced to the crankshaft, and all manner of traps and dams are installed in the pan to hold the oil in the pan near the pump pickup.

Vacuum pumps and dry sump systems fix several of these conditions. By pulling a low-pressure on the oil pan, up to a maximum of about 18 in. Hg, air is pulled from the oil-air mix, and the oil falls away from the crank more quickly. The only reported downside is that at very high vacuum levels some racers report reduced wrist pin life as the amount of oil mist in the crankcase it reduced by the increased vacuum levels. This effect can be mitigated by using pistons with oil feeds running from the oil control ring groove into the pin bore, piston oilers, or coating the wrist pins with a diamond-like coating (DLC) and running the pin clearance a little looser.

If you're interested, there are a number of good resources out there that you can go to and read up on pumps and pump related design criteria. A good overview is located here, at Wikipedia: https://en.wikipedia.org/wiki/Pump. ■

SCHUMANN'S SALES AND SERVICE FOR WET-SUMP OILING

-Greg McConiga

There's a guy I've met who's probably forgotten more about wet sump oil pump design than most experts will ever know. I got to meet the man in person this year at PRI when I made it a point to attend his Friday seminar and put a face to the voice on the other end of the phone.

I've used Schumann's a number of times for the modified street engines that I've built in the little restoration shop where I work and I've had the chance to speak to him long-distance often. Verne has always been generous with his time and gracious in helping me understand what I don't know — which is a lot, as my wife or any number of my friends will cheerfully attest. Verne and his company are the best resource out there if you're racing in a class that requires running a wet sump lubrication system.

He's created and patented several very clever work-arounds that make a wet sump oil pump work better than what the original engineers ever envisioned, particularly as it applies to the punishing world of racing.

Some of the innovations that Schumann's has brought to market range from improved internal oil distribution and pressure balancing — designed to minimize pressure thrust and vibration across the gears or rotors — to entirely new designs that eliminate the internal pressure relief/bypass system that's so prone to creating excessive oil heating and the violent pump drive/distributor/cam/timing chain loading that occurs when the throttle is slammed shut at the end of the straightaway.

The Schumann 140 System uses either a single- or dual ball-type relief valve to control pressure and volume by being sized to relieve 140% of the pump's capacity externally, directly into the pan, instead of recirculating the oil internally across the suction and discharge sections of the pump. Schumann's properly-sized external relief system eliminates the spool valve type internal relief and fixes two problems that these original designs created: one, adding heat to the oil, and two, pressure locking in extreme conditions, which can lead to suction-side reversion and aeration as the oil backflows out of the pump suction pipe and gulps air. Coming to the market is a two-stage 140 System that controls pressure at idle on a separate relief from the second stage that controls pressure at high rpm. This dual design allows control of both the low-speed and high-speed pressure settings without worry of reduced oil pressure at idle or near idle engine speeds.

A third Schumann innovation is the Schumann's Energy Recovery system, which made its debut a couple of years ago at the Engine Masters competition. By routing the relief volume out of the pump and turning it so that it blows back into the side of the pump pickup piping in the direction of flow, this wickedly simple and immensely clever addition reduces oil pump power consumption and functions like an eductor pump, boosting oil flow up out of the pan and into the oil pump. Dyno testing has shown that as much as 14 horsepower is recovered with a correctly installed Energy Recovery system!

While racing and inventive problem solving consumes much of the typical day at Schumann's, they also offer a wide range of street or street and strip wet sump engine oil pump solutions for everything from world record-holding Stock and Super Stock racers to weekend warriors and local track racers. If you're running a wet sump and you want the best solution available, give them a call, and tell them Performance Technician Online sent you. ■

SCHUMANN MODS FOR BALANCED FLOW AND PUMP LOAD

Here's an example of some of the internal pump work typical of what Verne Schumann does. The holes drilled through the ring apex and channels on the rotor and ring face provide a way for pressure to equalize across the pump, while the lubrication grooves in the housing and alongside the rotor drive shaft float the ring and rotor away from the housing. I've used his pumps in a number of street and racing applications with excellent results. He also offers a selection of copper gaskets to mount the more common pumps because his research indicates that leaks at that interface are more frequent and severe than what is commonly believed.

Schumann's Dynamic Performance

563-381-2416 Schumannsdynamicperformance.com/

FINISH LINE

-Greg McConiga, Executive Technical Editor

WANDERING FULMINATIONS ON HIGH-PERFORMANCE

DON'T WORRY! THE REST OF US DON'T KNOW WHAT WE'RE DOING, EITHER

I thought I'd know when I grew up.

I thought there would be a day when I knew I was an adult — knew what I was supposed to be doing — that I would know to be responsible and make good decisions and not let one thing get past me. I thought I'd be like I thought my parents were, and as I thought all adults were. Big surprise — that day never came.

What I've discovered is that everyone I've ever known, seen, heard, talked to, or observed is in the same boat I'm in. I'm grown up chronologically, but still don't have a firm grip on all those grownup things like life insurance, getting the lawn mower blades sharpened before mowing season, retirement planning, or avoiding repeating a good dirty joke.

This does not appear to be anything related to background, upbringing, ethnic group, gender, education, power, position, or wealth. Life gets busy, things that should get done don't get done, and days turn to weeks turn to months turn to years, and the next thing you know you aren't only not getting everything done you should get done, you don't even care about getting most of it done most of the time!

Part of this is due to the moving target that is this thing called life. There are tens of thousands of people out there each building, inventing, manufacturing, or developing thousands of new things all the time, and the fact of the matter is that all knowledge has a shelf life because sooner or later all those people overwhelm your ability to keep up. You go along for a while, being pretty adult-like, then suddenly something else you should be doing, not doing, eating, not eating, driving, not driving, buying or throwing away shows up on your radar and damned if you're not such a good adult after all.

There's a sweet spot in life. You're past the fast car and motorcycle, let's-stay-up-all-night-and-drink-beer-and-play-cards part, usually right before the you're-married-with-kids part, when you're young enough and strong enough to do what you want to do and old enough and focused enough to learn fast and do good work. Old enough to work, young enough to love what you do, and to do it with a passion. You're "on plane," as the boat guys like to say, and you're moving on.

Time passes, distractions come and go, the kids come and time and resources are limited, so you come off plane and go into cruise mode for a while, plying your trade successfully, accumulating friends and enemies, and trying to keep up with adult stuff like college funds (you could save all you make these days and never cover that), medical bills (DO YOU KNOW WHAT YOUR SON JUMPED OFF OF TODAY?? Uh... the roof? And why is it when he's a suicidal maniac, he's suddenly MY son, when every other time he's YOUR son...? The mystery of the woman begins to deepen even more during these times. Of course, he called the other day and now he's buying HIS first motorcycle. I immediately said, "Do you know what YOUR son is buying NOW???!!?" before she could get it out. I'm old, but I'm treacherous...).

We're now full circle. Double income no kids (DINKs) to single income two kids, to two kids one and a half incomes back to double income no kids. And old — did I mention old? And absolutely no clue as to what I'm to do now that I'm not only grown up, but old. I've got a ton of work to do at the shop, my office is still a mess, there're still things that need to be painted and fixed, and I'm pretty sure I'm under-insured — or at least that's what my agent tells me. Doc says I'm too fat and shouldn't eat sweets. I'm so stiff and sore from a lifetime of pulling wrenches that what don't hurt, don't work (which is another problem altogether, don't ask...).

Still, we soldier on, doing the best job at being an adult we can — making to-do lists, picking away at keeping up, and making progress where there's progress to be made.

Building race cars and racing engines is good practice for life. It's good therapy, it keeps the mind and body active, and it teaches patience and perseverance. It keeps you powered up and engaged, and I don't know of another hobby or vocation that presents more challenges as you work your way through putting the parts supplied by a hundred different vendors together to function as the finished product. The wellspring of life is activity; physical and mental, and it takes passion to get up every day and power through a list of 50 challenges before your noon meal. It also takes a great deal of discipline to avoid becoming an old person. While we may be old in terms of our days among the living, the last thing we should do is embrace the stereotypical curmudgeonly old geezer — not until we are so far gone that it's the only thing left to us. Then we should hold that banner high and embrace it because – well, why not?

If you love the sport and enjoy the work, then just plan on working until lunch the day of your funeral and most of the things that don't really matter won't even make it to your conscious thoughts. Don't worry about being right or wrong or worry about becoming an adult. Keep asking questions and learning and doing what you love to do because in the end, the other guy doesn't know what he's doing, either. No worries! ■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