The Oil Report
March 2021

Oil the News that's Fit to Print!

One Size Doesn't Fit All

by Travis Heffelfinger, Senior Analyst

Here's an interesting question we received recently from Pete, one of our long-time customers:

"Needed to ask you about AMSoil OE synthetic oil. The change interval that is suggested for that oil is whatever the vehicle manufacturer has specified for that particular vehicle. But what have you seen from the TBNs that you have run on that oil? It doesn't make sense that in my old 01 Maxima it would only be good 3000 miles but in a brand new vehicle it could be good for 10K."

Pete has a point. Why would the same oil wear out faster just because the manufacturer recommends a shorter oil change interval? If the oil can hold up for 10,000 miles or more in some engines, shouldn't it be able to do so in any type of engine?

Of course, there are some reasonable explanations that Amsoil (or any oil manufacturer) might give for this. The industry is generally moving towards longer oil change recommendations because modern engines are built to more exacting standards than they were even ten years ago, allowing for improved efficiency and less damage to the oil. Plus, you might have to adjust the oil change interval in the same exact engine based on whether you're seeing "severe" duty or not, so it's probably reasonable to think that some types of engines would just treat the oil a little more harshly and require a shorter oil run, right?

The cynical side of me, though, says that the real answer to this question probably has more to do with the legal department than the oil's engineers. Regardless of how good you think your oil is, if you start telling customers they can ignore the original engine manufacturer's recommendations, you're probably opening yourself up to some legal headaches that the head office just doesn't want to deal with.

But true as that may be, it's not a very good answer for Pete, or the rest of our customers who are just looking for the best advice on how to treat their vehicles. So setting aside specific recommendations for a moment, let's get to the nut of Pete's question… Does the life expectancy of the oil change based on what engine it's used in?

The Tale of the TBN

There are several factors that we use to determine if your oil can be run longer, but Pete asked specifically about the TBN, so let's focus on that for now. For those who don't know, the TBN (Total

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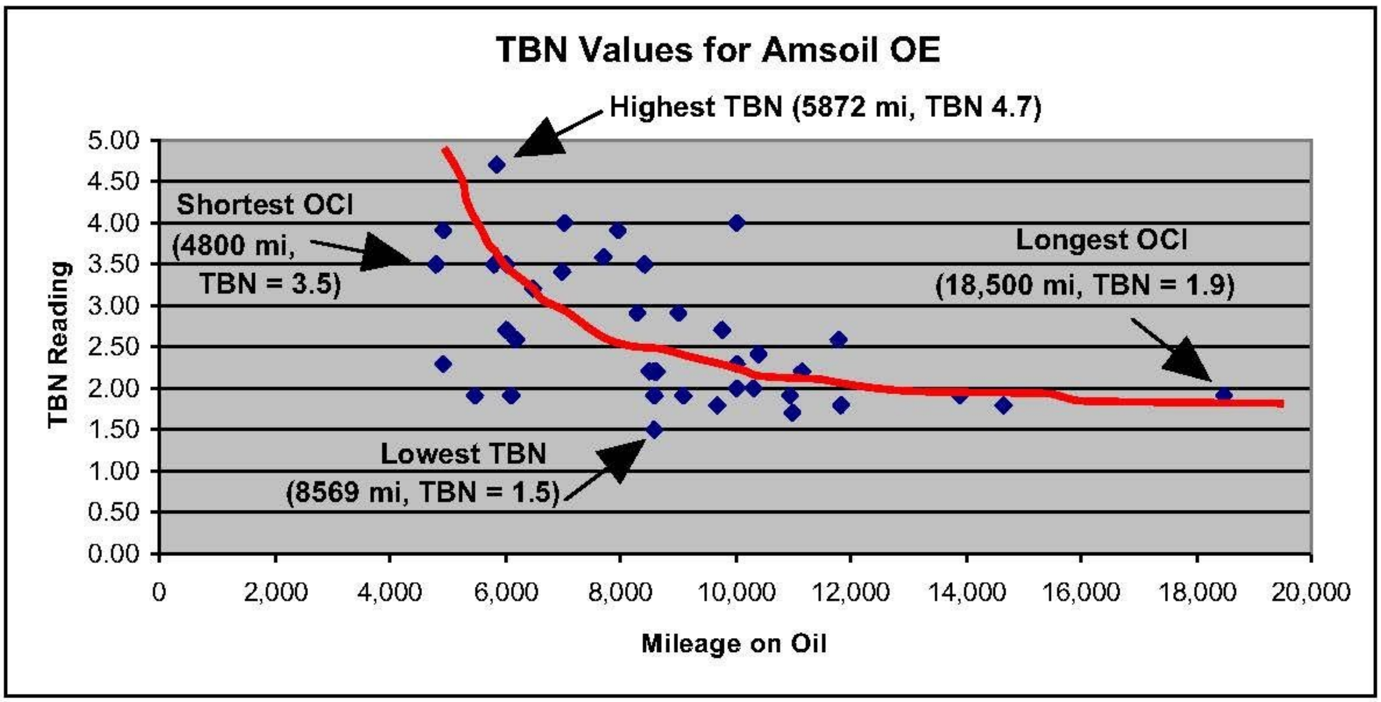
Base Number) measures the amount of active additive remaining in the oil. A typical gasoline-engine oil might have a starting TBN between 6.0 and 8.0, while diesel-use engine oils tend to have a higher TBN of 11.0 or 12.0, since they tend have more calcium and magnesium (the TBN is based on the levels of calcium sulfinate and/or magnesium sulfinate in the oil).

But regardless of where a TBN starts, they all end up in the same place—0.0—if the oil is run too long. Once the TBN is down to zero, it means that the oil is no longer able to neutralize acids produced by the engine. As a general rule of thumb, we usually say that once a TBN gets down to 1.0 to 2.0, it would probably be a good idea not to run the oil much longer, to avoid running out of those active acid-neutralizing agents.

To answer Pete's question about how the TBN of Amsoil OE holds up in different engines, we searched our database to find the recent TBN results we've seen from that type of oil. Since the TBN is an optional test, we don't run it on every sample we see, but customers who use Amsoil tend to be pretty interested in seeing how long they can run their oil, so we have a pretty good representation for that oil type. We plotted nearly 50 samples' TBN results against the mileage on the oil, and came up with this



graph:

The banana-shaped line we've drawn approximates the "average" TBN for this type of oil over a given mileage. You can see that the TBN tends to drop quickly at first, but the longer the oil is run, the slower the TBN drops. Of the samples we tested, none of them had a TBN less than 1.5, so even on very long oil change intervals, this Amsoil OE oil tends to retain plenty of active additive.

Also note that the actual test results (the dots) can stray pretty far from that line on either side, so even though the TBN readings tend to follow a particular pattern, there can be a pretty wide deviation in individual test results. Just at a glance, you can easily see that the sample with the highest TBN reading didn't have the lowest mileage on the oil, nor did the sample with the longest oil run (a whopping 18,500 miles) have the lowest TBN reading. In fact, the lowest TBN came after a fairly middle-of-the-road 8,569-mile oil change interval.

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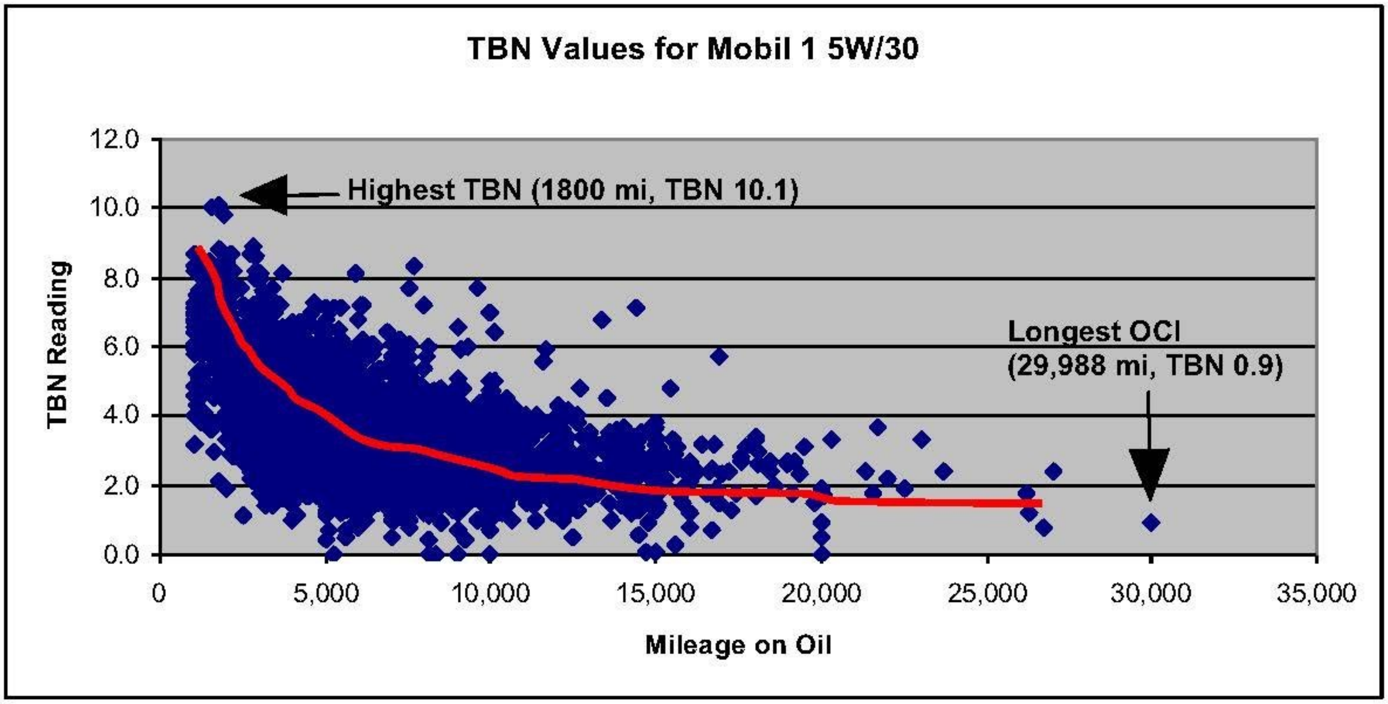
And before we get too hung up on looking at just Amsoil OE, we ran the same analysis for one of the most common oil types we've tested, Mobil 1 5W/30, resulting in the chart below.

This graph for Mobil 1 5W/30 covers nearly 5,000 samples with TBNs, and the scale is a little different than the Amsoil OE chart, but you can see that banana-shaped curve that we've drawn, approximating the average TBN for a given mileage, is exactly the same as in the Amsoil OE chart. Once again, the highest TBN was not the shortest oil run, and the lowest TBN was not the longest oil run. So even



though we have many more TBN data points for Mobil 1 than we do Amsoil OE, the overall trends for TBNs are similar, and would be with just about any type of oil you could name.

So what other factors might be affecting the TBN? To find out, we ranked all the samples according to both mileage and TBN reading, and came up with the best and the worst of the bunch.

One factor that definitely stood out was make-up oil, of course. If you add some fresh oil in between oil changes to top up your oil level, you're infusing the oil with more active additives, and diluting wear metals and contaminants at the same time. That's why we often say that you shouldn't be too upset about adding a quart or two of oil over the course of your regular oil interval (assuming you don't have a noticeable leak, of course), since that fresh oil might buy you a few thousand extra miles before you have to do a full oil change. In this case, all of the samples that noted adding a quart of oil or more ranked in the top half of the results, and the Amsoil samples with the most oil added (2.5 and 3 quarts) ranked at numbers 2 and 7, respectively. On the other hand, the overall best-ranked sample, with a TBN of 4.0 after 10,000 miles, didn't add any oil in that time, according to their oil slip, so make-up oil alone is not the only relevant factor.

Pete's original question was about manufacturer's recommended oil change intervals. We don't have a list of the recommended OCI for every engine we've tested, so we'll have to settle for looking at some other factors, like the age and size of the engine.

What Affects TBN?

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For both the Amsoil and the Mobil 1 samples, the age of the engine didn't seem to make much of a difference. We had engines from the late 90's and early 2000's in the top ten percent on both charts, mixed right in with new engines from the last few model years. The total engine mileage was also mixed, with higher-mileage engines ranked right alongside brand new engines in their first few oil changes.

Engine size is one factor that I thought would end up playing a pretty big role, but I wasn't sure which way it would go. On the one hand, larger engines tend to work harder, so I wondered if the larger 6-cylinder engines and big V8s might burn through the active additive more quickly than smaller engines. On the other hand, 4-cylinder engines also tend to have smaller oil sumps, meaning less total oil volume in the engine, so maybe their active additives get used up sooner.

Turns out these results were pretty mixed as well… there was a bit of a trend for smaller engines to hold a higher TBN for longer oil runs, but there were plenty of larger engines near the top ranks of both lists, and vice versa. Seems like the extra oil in the sump of the larger engines pretty much balances out the extra work they have to do, resulting in a mostly even distribution of engine sizes across the rankings in both charts.

So what does all this tell us? Well, at least as far as the TBN goes, it doesn't look like the type of engine has much of an influence on how long the active additive lasts in the oil. Engines of the exact same type (and in some cases, even the exact same engines) were ranked both high and low in our results, so it looks like individual driving habits and the behavior of each particular engine play a much larger role than engine sizes, model years, manufacturers, or any other criteria we could see.

When you get right down to it, though, the TBN is only one factor in determining whether or not it's safe to run the oil longer. It's a valuable tool, but we also have to look at other factors, like wear metals, insolubles, viscosity, and contaminants, any of which could indicate that you shouldn't run the oil any longer, even if the TBN is still good.

What does the Total Base Number actually measure?

The TBN test measures the reserve alkalinity of the oil – that is, the oil's capacity to neutralize acids produced by the engine during the combustion process. We use a machine called a titrator to determine how much acid can be added before the "active" acid-neutralizing additives, such as calcium sulfinate and magnesium sulfinate, are completely used up.

The TBN is expressed in terms of the equivalent amount of potassium hydroxide (chemical formula: KOH) in milligrams that it would take to neutralize the same amount of acid neutralized by one gram of the oil sample. If 1g of your oil neutralizes as much acid as 3.2mg of potassium hydroxide, it has a Total Base Number of 3.2 mg(KOH)/g. That's quite a mouthful, though, so we just say it has a TBN of 3.2.

For more information on the TBN, and whether it would be useful to you, check out the article on our website: **Do I Need a TBN?**

The bottom line is this: the engine manufacturers don't know anything about your particular driving habits and maintenance routines, so they'll base their recommendations on what should work best for most drivers. The best way to determine how long you should run your oil in your particular vehicle is to get it tested.

When you get your oil analyzed at Blackstone, we're looking at the specific conditions for your specific engine, which is why we can tell you if it's okay to add an extra 2,000 or 3,000 miles on your next fill, regardless of your current OCI. Just check "Yes" next to the question "Are you interested in extended oil use?" on the back of your next oil slip, and maybe you too will be free to explore the world of extended oil use!

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Report of the Month

This 2015 Harley Davidson Road Glide has a problem.
Can you tell what it is?

To learn more about where the elements are coming from, click here.

UNIT

MAKE/MODEL: Harley Davidson Twin Cam 103 — OIL TYPE & GRADE: Red Line 20W/50
FUEL TYPE: Gasoline (Unleaded) — OIL USE INTERVAL: 3,902 Miles
ADDITIONAL INFO: FLTRXS, new cams, oil pump

COMMENTS

The owner reports: Just wanted to thank you. After I received my last terrible report I tore down the top end of the engine and found both pistons had seized in the cylinders at some point in between oil changes. I believe this report saved me a ton of money. The bottom end of the engine was fine, but without knowing this was happening, it would have destroyed the crankshaft and related components. Again, thank you!

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	3,902		4,254	7,380	769	4,240	4,503	
MI/HR on Unit	38,677		35,775	31,521	24,141	23,372	19,132	
Sample Date	6/13/2020		3/11/2020	5/29/2019	3/15/2019	11/3/2018	5/1/2018	
Make Up Oil Added	0 qts		0.5 qts	0.75 qts	0 qts	0 qts	0 qts	
ALUMINUM	**22**	5	**18**	7	4	5	5	5
CHROMIUM	**6**	1	**9**	1	0	1	1	0
IRON	**93**	13	**103**	13	8	10	14	12
COPPER	8	20	16	9	9	8	14	15
LEAD	0	1	3	0	3	0	1	2
TIN	0	0	0	0	0	0	0	1
MOLYBDENUM	362	74	101	99	84	99	96	115
NICKEL	1	0	2	0	0	0	1	0
MANGANESE	2	2	18	1	2	0	1	4
SILVER	0	0	0	0	1	0	0	0
TITANIUM	1	0	0	0	0	0	0	0
POTASSIUM	1	4	3	2	1	2	2	2
BORON	60	172	204	189	201	212	206	137
SILICON	18	11	12	5	4	5	6	12
SODIUM	6	5	5	6	6	6	5	19
CALCIUM	2764	2301	2616	2674	2261	2731	2691	2357
MAGNESIUM	25	196	53	21	17	26	28	308
PHOSPHORUS	1656	1152	1255	1129	1360	1361	1320	1141
ZINC	1900	1431	1554	1466	1479	1612	1638	1417
BARIUM	0	2	1	2	1	3	6	1

PROPERTIES

		Values Should Be*					
SUS Viscosity @ 210°F	93.8	75-95	**109.8**	**119.5**	100.4	**112.9**	**113.8**
cSt Viscosity @ 100°C	18.88	14.3-19.4	**22.64**	**24.84**	20.45	**23.35**	**23.55**
Flashpoint in °F	455	>385	445	430	445	445	450
Fuel %	<0.5	<2.0	<0.5	<0.5	<0.5	<0.5	<0.5
Antifreeze %	-	0.0	-	-	-	-	-
Water %	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Insolubles %	0.3	<0.6	0.3	0.2	0.2	TR	0.2
TBN							
TAN							
ISO Code							

* THIS COLUMN APPLIES ONLY TO THE CURRENT SAMPLE

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LIABILITY LIMITED TO COST OF ANALYSIS

Report of the Month

This 1919 Ballot Indy Car doesn't necessarily have a problem, but it's wearing more than it used to. Why?

To learn more about where the elements are coming from, click here.

UNIT

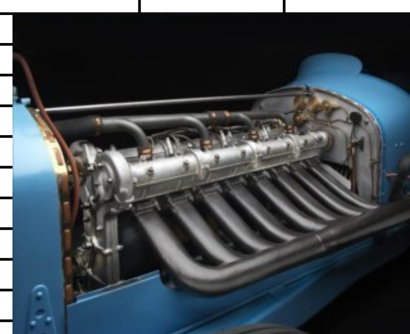
MAKE/MODEL: Ballot 8 Cyl	OIL TYPE & GRADE: Morris 40W
FUEL TYPE: Gasoline (Leaded)	OIL USE INTERVAL: 100 Miles
ADDITIONAL INFO: 1919 Ballot Indy Car	

COMMENTS

You know better than we do what might have changed for this engine over the last 15 years. It's a pretty safe bet that it doesn't see a lot of use, so mild corrosion could be a factor in the increased wear. Corrosion wouldn't usually cause much copper and chrome to show up though. Maybe work was done? In that case the metals could be from wear-in or just shifting parts around. This 8-cyl. is wearing differently than it used to, though we'd hesitate to say there's a problem. Insolubles (solids) are low & no fuel/water is present. Let us know what you find out.

ELEMENTS IN PARTS PER MILLION

		UNIT / LOCATION AVERAGES						UNIVERSAL AVERAGES
MI/HR on Oil	100		100	200				
MI/HR on Unit	150			200				
Sample Date	1/19/2021		7/3/2006	7/11/2001				
Make Up Oil Added	0 qts			10 qts				
ALUMINUM	4	4	3	4				4
CHROMIUM	**6**	4	2	3				3
IRON	**43**	25	16	15				16
COPPER	**93**	54	56	14				35
LEAD	153	179	261	123				192
TIN	1	1	0	1				1
MOLYBDENUM	18	26	28	33				31
NICKEL	1	0	0	0				0
MANGANESE	1	0	0	0				0
SILVER	0	0	0	0				0
TITANIUM	0	0	0	0				0
POTASSIUM	4	2	1	0				1
BORON	173	123	76	119				98
SILICON	12	9	6	9				8
SODIUM	6	7	8	7				8
CALCIUM	1784	1036	789	534				662
MAGNESIUM	16	550	687	948				818
PHOSPHORUS	604	724	770	799				785
ZINC	572	783	896	880				888
BARIUM	0	0	0	1				1



This car lives at the Revs Institute — a nonprofit educational institution dedicated to the study, preservation, conservation, and restoration of historically significant automobiles — in Naples, Florida. Because their main goal is historical accuracy, the whole car (including the engine) has been restored as closely as possible to its original state.

It's interesting that an engine built more than 100 years ago has much in common with today's engines. The same metals are being used, just in slightly different ways. The main bearings in the crank are roller bearings, as are the bearings in the camshaft. The rods are regular babbit and the wrist pins are a copper bronze material that was commonly used back in the day.

They sampled the engine in 2001 and 2006, and then car sat until they shipped it to the UK for restoration. The engine, however, was only taken apart and cleaned — it wasn't rebuilt. It basically didn't have a lot of running till late 2018, and then it went back to Paris in 2019 for its 100th anniversary. So the engine has not run much, and it probably only had maybe 100 miles on it from 2006 until the time it was disassembled, cleaned, and put back together. The oil is a Morris 40W and what you're seeing is probably a little corrosion plus a little metal just from removing parts, cleaning them, and then reinstalling them.

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