By Chuck Andrews

END SLUDGE

The following paragraph is copied from the Saab USA letter addressed to 9-3 and 955 owners about oil sludging (dated 6/3/05):

"The primary cause of engine oil sludge is premature decomposition of the oil due to a number of factors or combination of factors. These factors include: short driving trips of five to ten minutes when the engine does not warm up sufficiently, driving in stop-and-go traffic, driving in dusty conditions, towing trailers, using low-grade-specification oil not recommended by Saab, or oil changes not meeting the minimum requirements as recommended in the service schedule. When these factors or combination of factors occur, the engine oil thickens making it more difficult to provide adequate engine lubrication."

I'll begin this column with some explanations and disclaimers. As most of you know, I am not a scientist; I don't get paid to research Saab assets or liabilities. The results of my work on the sludge issue could be called "field tests" or "results." Most of what I write about includes results from experience from the actual cars or published reports. I will try to explain the inherent problems with this 4-cylinder 9-3 and 9-5 engine and the test results that I have to date. It takes months and thousands of miles to verify some of the information I am trying to prove or disprove. I'll say again that there are engineers at the Saab/GM Power Train Division in Trollhättan who already know what I'm finding out. Further explanation about this engine series will also help you to understand the problems better.

When this engine was introduced it was called "low friction." There are several aspects to the low friction engine that I will discuss but I want to mention first the item I found at www.autoweb.com.au. It says that the oil pump's "overcapacity had been reduced slightly and a lighter timing cover was now being used." The facts about the pump are only relevant because of the other changes made to the engine.

Thanks to all of you who have sent me information and to Stephen Goldberger who got me thinking about this engine design. He reminded me that with low tension piston rings there is less friction but more blowby, which is combustion by-products escaping past the rings and pistons into the crank case and oil system. These products would include moisture and unburned fuel. To combat this situation, Saab used an elaborate emissions system to remove the excess vapors, etc. The sludging has been blamed on the emissions system and I believe there have been five variations of this system by now, which is another subject. To say the emissions system is totally innocent would be foolish but I think Saab has used it as a cheap way to avoid the real problems. All the modifications made to the emissions systems are cheap. Several didn't work and they re-modified back to the second series.

Take a look on line at www.Angry[illegible]pliance.com. You'll find a great explanation and progression on the emissions system and the writer is convinced that it solved his sludging problems.

We now will go back to the by-products that have ended up in the oil. We know that these by-products are now in the oil sump and are coating the internal engine parts. The first line of defense for this condition (oil dilution) is to boil away the fuel and moisture so the emissions system can dispose of it (re-burned in the engine). To accomplish this, the current oil temperature thermostat for the oil cooler opens at 221 degrees. We now have an additional 56 degree higher oil temperature than in some previous Saabs. The 1991 - 1993 9000 oil cooler thermostat opens at 165 degrees. To follow this thread we'll go to the turbo charger. It is cooled and lubricated by engine oil as well as being cooled by the engine coolant. The turbo in my 9-5 Aero runs about 1200 degrees when cruising at 65 mph, the oil temperature will be in the upper 190s to low 200s and the water temperature low 190s but will go over 212 at idle. Back in the 1990s, on the 9000, we ran very close to the same temperature in the turbo but with much cooler oil temperatures. When we come to a stop and idle before shutting the engine down with the 9-5, the oil temperature does not come down like it did in the 9000 because the oil thermostat has not opened to allow the oil to cool, so idling does not lower the turbo temperature quickly enough to protect the turbo and the oil.

Consequently, we have seen many 9-5 turbos fail and the oil inlet tube shows significant sludge deposits restricting the oil flow. I think when the outside air temperature is in the 80+ range, this is a significant hot spot that oxidizes the oil. I am sure, because of the blowby in the cylinders, that the pistons are also a contributor in the oxidation process (see picture).

The piston on the right is from our "low friction" 9-5 and the one on the left is from a 1985 900T. Note the position of the piston rings and compare the size of the piston skirts. Less contact with the cylinder wall makes for low friction but it allows less heat transfer to the engine block which has to raise the temperature of the piston.

Beyond the oil's capability to control the sludging process, we now see the difficulty with the oil pump and screen. All oil has to pass through the intake screen which is very fine (see picture) to protect a less robust oil

Oil pick ups. The top is from a 9-5 with a .026 wire in the mesh. The bottom is from a 9000 with holes that are larger. One of our first solutions for the 9-5 lubrication problems was maybe a bigger mesh in the screen but we soon discarded that idea when we saw the pump construction. *All photographs by the author.*

pump. The screen becomes partially plugged first by the slime and sludge and gradually restricts the flow to the oil pump. Gradually, the result is lower oil volume from the pump followed by lower oil pressure (as friction increases engine wear accelerates) in turn causing more heat that causes more oxidation and sludging. Some of you are thinking that this process must take a long time (many, many miles). I'll report what the lab told me. When the antioxidants in the oil get below five percent by volume, the oxidation rate goes straight up. The oil, among other things, becomes so acidic it deteriorates the emissions hoses. The emissions hoses get soft, and the vacuum in them sucks the hoses shut and eventually sucks holes in them. Now we have more chemical imbalance, residue to deal with in the crank case, and a crippled emissions system.

Now to the oil issue. I have to give Stephen credit again for spurring my research and thinking. Stephen has stated that Mobil I 10W30 synthetic oil does not meet Saab's own specifications. I suggested to Stephen that I didn't think that even if it didn't meet the specification that the 0W40 oil would not make much difference. Boy, was I wrong! Let me explain about oil on the simple end. All the things that Stephen wrote about oil in NINES in the past are still relevant and are worth rereading.

On the Internet I found a NOACK volatility test from the year 2000. Remember when the 9-3s and 9-5s were introduced? Regular oils were prevalent and Saab semi-synthetics came along later. This volatility test determines the evaporation loss of lubricants in high-temperature service. The more motor oils vaporize, the thicker and heavier they become, contributing to poor circulation, reduced fuel economy, increased oil consumption and excessive wear and emissions. This testing showed that regular oils (there were several major brands listed) flashed off up to almost 20% by weight. That means the oil was gone by some percentage as well as a relative portion of the oil additive package. As the oil evaporated, the catalytic converter had to deal with this extra load. (Saab has had to replace some catalytic converters under warranty that I have seen and they were plugged almost solid)! The synthetic oils of that time were down to only 6% loss by weight and semi-synthetics as low as 12%. So, how long was that oil really good if it flashed off at a 20% rate? How about a 10,000 mile oil change with that oil? Remember, at that time, Saab was recommending up to 10,000 mile oil change intervals. How about 5,000 miles? In reality, 2,000 or 3,000 miles might be a stretch at that rate. We know that after the oil has started to sludge even one time, (it doesn't matter what oil we're talking about whether it's good or bad, just that its been used too long), the sludge and slime will not be removed unless an oil system flush is performed. Witness my 9-5 Aero with four oil changes at 4,000 miles, each with 10W30 Mobil I. The picture in the last issue of NINES of my oil pan showed that the sludge doesn't go away. It just hangs in there! So even if you have been diligent with your oil changes, one slip up could cause long-term issues. What I'm trying to say is that some of the engine failures, etc., may have been caused from as far back as the first or second oil change six or seven years ago.

According to Saab's letter, in the first paragraph, their solution to the sludging issue is to use full synthetic oil changed more frequently. This is a good suggestion, but it will not remove sludge already existing in the engine nor will it keep further sludge damage from occurring. As proof of this I will relate my initial gauge readings and tests with my Aero. When we got the car ready for the first road test I set the alarms for several of the readings. I set the oil pressure alarm at 10 psi, the water temperature at 212 degrees and the turbo temperature at 1,500 degrees. After driving for several miles I began to hear an alarm at idle. I thought it must be the tachometer because in my excitement to test out the gauges I hadn't set the parameters for it. After fiddling with several of the systems I discovered that my oil pressure at idle was dipping to 9 psi from time to time. Ouch! I was not prepared for that! I almost panicked but then reason set in. What do you do with an unknown or unverified reading on any gauge? Get a second opinion! Maybe we got the shop oil pressure gauge hooked to the car and found out the new electric gauge did not read correctly. It read 8 lbs low at idle. What a relief. So, on with the tests. After several thousand miles, a 4,000 oil analysis, which was okay, and now at the 5,000 mark we ran some tests to determine if removing the sludge/slime from my engine with an oil flush would help the pressure. (Remember, the pan had been removed and cleaned just a few thousand miles before.) I have developed a standard road test that is 10 miles long to stabilize the engine temps. After the road test we brought the car in and tested the pressure. At 950 rpm we had 20psi, at 2000 rpm we had 37psi, and at 3000 rpm we had 50 psi. We drained the 10W30 Mobil 1 into a clean pan, put regular oil in the engine for the flush and completed the flush procedure. When the flush was completed, we drained the oil and replaced it with the original Mobil I 10W30 oil that had 5,000 miles on it so

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we could get an accurate test. Once again, I started with a road test and then checked oil pressure. At 950 rpm we had 24 lbs., at 2000 rpm we had 39psi and 3000 rpm we had 55psi. Then, to prove that Stephen was correct, we changed the oil and filter to 5W40, completed the road test and found that the oil pressure at idle was now 27 psi, (a long way from the 9 psi that I thought that I had) 2000 rpm had increased to 42 psi, and 3000 rpm is at 58 psi. Boy, do I feel better about my Aero! I think that this proves that with a "clean" engine and proper oil these cars could live a long, long time. One thing I have to remind you about is the oil appearance. It is going to be black or a dark color no matter what you do. The contamination of the oil is just part of the process. You just have to keep it changed often enough. One of our customers has been comparing a 1997 9000 CSE to his 1999 9-5. Both cars go the same distance with the same conditions and the CSE will have clean clear oil on the dip stick at the 3000 oil change and the 9-5 will be pitch black. Neither car has had any engine problems at 80,000 miles.

The testing with the turbo cool down involving the changing of oil cooler temperature thermostats is ongoing. It is difficult to verify hot weather conditions during a Minnesota winter, but we can work on the oil dilution part of it. I will report findings when I can be sure the results are accurate.

After looking at the two most common synthetic oils available to us, we have decided to switch to Amsoil 5W40 synthetic. Our choice is based on the Amsoil having a higher phosphate level as part of its additive package. This is an antioxidant and also prevents corrosion. We will be testing this oil in my 9-5 Aero against our previous choice of Mobil I. We will be using 5000 mile change intervals and oil analysis with oilmedic.com so we can monitor oil performance and maybe extend the interval when we have evidence to back up our decision.

By the time this article is in print, we expect to have a flow chart with full recommendations on how to service your car and how to provide maximum enjoyment and life expectancy from your Saab. See our Web site at www.andrewsofprinceton.com.

Oil thermostats: on the left is a 9-5 (B204/B234 94) 225 degree. Center is B234-M93 167 degree and the right is B202 and opens at 194. While they all interchange I believe it is necessary to use the 225 degree in the winter in the North for sure to help control oil dilution. I think our testing will eventually prove that the 167 degree could be used in the warmer climates all year and in the North in the summer.

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