

# Ferrari 308/328

## **DIY Maintenance Experiences**



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#### Preface

This collection of Do It Yourself (DIY) experiences is provided as a service to others that enjoy learning about their Ferrari 308/328 cars. It is a result of numerous hours of searching the Internet and FerrariChat to find, study and learn about these classics. Many owners enjoy working on their own cars and due to the age of the car, detailed repair or maintenance write ups are often limited or difficult to find. When one enthusiast shares their experience of doing a repair or maintenance event, it is extremely valuable to other enthusiasts to learn and perhaps try the activity themselves. This collection of DIY descriptions does not replace shop manuals or professional mechanics, but is meant to augment them by providing the reader a better understanding of the repair or maintenance event. In addition, the reader should develop an appreciation for the time, effort and knowledge that goes into maintaining these classic cars.

I would like to express my appreciation to the many people that contributed their time in writing the DIY experiences. The descriptions contained in this collection are more common DIY work items I collected and would attempt based on my current mechanical ability and knowledge. Maintenance items that are beyond my skill level, I leave for my mechanic. If you are considering performing any of these DIYs, please carefully consider your current skill level and whether you can perform the work safely. Safety must be kept as a primary requirement for working on any heavy car and where fuel vapor may cause a fire. If you are attempting any maintenance work, consult a shop manual and seek advice prior to starting your work.

The DIY experiences contained in this book are personal descriptions by the authors summarizing how they managed the maintenance item. There is NO guarantee that these descriptions are correct or are suitable for your needs. These are simply descriptions of what others have done to maintain or repair their cars.

JohnnyS

### Ferrari 328 Oil Change

Carl Rose

May 2003

Any enthusiast can change the oil in their Ferrari- this is not a mystical or difficult task, although more involved than many other cars I've done. Opinions differ as to frequency: every 2.5-5K for driven cars, every 6-12 months for garage furniture (280mi in past 6 months in this instance). Some also recommend changing oil after warming car to suspend any debris & make flush more thorough. *[Example car is late-88 but 328 series is identical]* 

Time: Approximately 2 hours (I would imagine less with repetition!)

Tools required: 17mm deep 6pt 3/8" socket Torque wrench Oil drain pan (sufficient to hold ~10 quarts) Oil filter or strap wrench Floor jack and stand Wheel stop blocks Oil pour funnel Newspaper Lots of paper towels

Parts required:

Oil filter #111782 (UFI#2316201/#191993 or Baldwin #B253 \$10-15).

*Comment:* Concours requires UFI, many mechanics recommend Baldwin. Fram PH-

2804-1 is also listed in OEM specifications but other two seem to be preferred. UFI filter

typically is sourced from dealers or suppliers, while the Baldwin may be found locally at

truck supply depots.

[Note: I understand there were problems with some of the early UFI filters (suffix

ending -00) rupturing the mounting gasket; ensure you use the later -01 version)

Oil (10 quarts of your favorite; AGIP SINT 10W-40 is factory specified)



*Comment:* Discussions of oil are akin to theological debate. AGIP SINT 2000 is a semisynthetic blend sourced only at dealers (\$8/liter) or direct from AGIP USA (800-832-

8777; \$5.60/liter w/shipping). Castrol now makes a similar "blend" in 20W-50 (good for warmer climates) for about \$2.50/qt. For full synthetic Mobil 1 is the most popular choice (15W-50) for \$4.50-5/qt.

Oil drain plug copper washer #10257060 (\$1); NAPA part #704-1365 is functional (16mm

#### ID/22mm OD/1.3mm thick) & should work fine (\$0.88).

#### Baldwin & UFI filters:

First, while you're still clean, raise the decklid and drape the paintwork with thick soft towels & tape in place. I was unable to slide a large oil drain pan under the car without lifting car. Accordingly block the front wheels, then lift the left rear (jack on frame rail) slightly and set on stand. This will also improve drainage as plug is on right side of oil



Engine oil drain plug is horizontally-oriented 17mm hex bolt and marked "OLIO MOTORE" on underside of pan [transmission oil drain plug is vertical allen-head plug].Access from just in front of passenger rear wheel. Spread more newspaper down than you think you'd ever need. Loosen drain plug slightly (standard RH thread, mine had been installed very tight).

Set drain pan in place and remove plug. The oil drains quite quickly so you may want to regulate this with your finger to avoid splashing.

When flow from pan has slowed, remove oil cap to vent engine. Pack several paper

towels around the oil filter and remove using filter wrench. Folks recommend punching a hole at the apex to drain the filter, but the previously installed Baldwin filter didn't leak a drop during removal. Wipe a bit of oil on the new filter rubber seal and install hand-tight. Tighten further using the filter wrench; I protected the nice white paint by covering the UFI filter with a Ziploc freezer baggie & lining inside of the filter wrench with masking tape. Not certain about a torque value, I went "quite snug". Many filters recommend <sup>3</sup>/<sub>4</sub> of a turn after the oil filter gasket makes contact with the sealing surface.



Clean the drain plug. I purchased several drain plug copper washers in advance, but none turned out to be the proper size (removed washer: ID 0.631", OD 0.825", thickness 0.053"; which translates to metric: ID 16mm, OD 21mm, 1.4mm thick). I flipped sealing side over and re-used. Thread this into the oil pan by hand then torque sequentially (couldn't find torque value in any of the manuals so I used 25 ft-lbs). Don't

guesstimate – use a torque wrench. Stripping the oil pan threads would make this much more interesting.

Wipe the oil pan fins clean (Simple Green) and carefully remove full oil drain pan from under car. Lower car to ground and remove front wheel blocks. Most auto parts stores recycle used motor oil at no charge.







My Prestone radiator funnel fit perfectly in the fill spout. Fill with 9 quarts of your favorite oil. Reinstall oil fill cap (clean off fingerprints!) and wipe up any spills.

Start and check for leaks (both drain plug & filter seal). Run the car until warm then shut off. Recheck the oil level 10-15 minutes later and add as necessary. My car requires about 9 liters total to register "full" on dipstick.

#### Changing the gear oil on a Ferrari 308, 328 or Mondial

#### by Robert Garvin

My dream is to share what I have learned working on my 1975 308 GT4. I am working on a book "Ferrari Service for Dummies or What I Learned on the Internet" If you find any mistakes please let me know and I will revise it. As most of you may or may not know, I decided 11 years ago that I wanted to do my own work as I loved my car so much I couldn't trust anyone to touch my precious Ferrari. I started on the original Ferrarilist.com and met many members who guided me along the way, many are here now also. I also had help from several experienced Ferrari mechanics whose names will be withheld as not to embarrass them with my acquaintance! I am also on several other Ferrari lists, as I am a nut and have all this free time when I am not working 10 hours a day! :-) I hope you enjoy what I have written and I can help some other poor soul who was as lost as I was 12 years ago. Please give me feedback, as I am in the slow process of becoming an amateur Ferrari mechanic! Respectfully, Rob (Robertone) Garven (This article was originally published <u>on Ferrarichat.com</u>)

Tools and or supplies needed:

1. 6 Quarts suitable oil (Swepco 201 80W-90, Agip Rotra LSX SAE 75W-90, Redline 75W-90) Oil needs to have a friction additive for the clutches in the differential! (*Jonathan's note: Many people including me have had excellent results with Redline 75W-90 NS*).

- 2. 10mm & 12mm allen hex wrench
- 3. 19mm & 22mm open end wrench
- 4. Suitable drain receptacle to catch and recycle oil
- 5. Rags or towels to wipe up spills etc.
- 6. Funnel and a piece of hose approximately 10 inches long.

Optional tools:

- 1.1 creeper
- 2. 1 large piece of card board (To catch any oil that may splash.)
- 3. 1 box of latex gloves
- 4.1 shop apron

Note: Never get under your car supported only by jacks. I have done this personally but I love my car more than myself. If you do this, make sure you have a good insurance policy. Your family will thank you, and at you memorial I will tell them I warned you in advance and try to buy parts off your car!

1. Make sure all work is done on a level and clean surface, you are sober and at least someone is around, (in shouting distance) in case you have an emergency. Get all the supplies you need ready at hand.

2. Raise car to a suitable height or use a lift, make sure the car is stable and even. If you use jack

stands make sure that they are placed so that they will not get in the way of your drain receptacle and are more importantly placed on the main tube frame in the appropriate locations.

3. Remove the battery ground cable. I have a green spin off knob that disconnects the battery ground cable and is very handy, not only when working on the car but when leaving it for an extended period of time as not to drain your battery. Note: I have never had any battery drain even when the car has set for over a month, some models have more drain and even need a trickle charger to keep them charged for as little as two weeks! *Jonathan's note: I never disconnect the battery to change the gear oil, but be careful not to short the starter motor to ground!* 

4. Loosen the 22mm transfer case fill plug first, because if you drain the transfer case and can't get the fill plug off, well you get the idea! (See below)



5. Place the receptacle under the transfer gear drain plug.

6. Loosen the transfer gear drain plug with a 19mm wrench.

7. Let the oil drain from the transfer case. There is not much oil in there but I place a receptacle and funnel under the hole to catch it all and leave it there for a while.





8. On the GT4 you must remove a rear aluminum heat shield cover that covers the gearbox overflow plug and hole.

9. Remove the gearbox oil filler / overflow plug with a 12mm allen socket, you will need an extension to reach it. It is on the rear of the gearbox near the left side of the differential.

10. Remove the gearbox drain plug with a 10mm allen socket wrench. This plug is located on the bottom of the car very near the engine oil plug. It is marked OLIO CAMBIO. I have heard several horror stories of someone draining the engine oil thinking it was the gearbox oil and well as stupid as it sounds, they were true stories with disastrous results.

11. Be advised there is allot of oil in there so after you loosen the plug, I hold it up to the threads after it is completely unthreaded and with one quick motion, move it away from the hole allowing the 6+ quarts of oil to drain into your suitable receptacle. If you are using one similar to mine that are available and given out by may local cities to help manage oil wastes do not forget to remove the cap, drain plug and pop the relief cap. I unwittingly forgot to remove the drain plug in the receptacle only to have the oil start to overflow and reach into the hot gearbox oil to remove it what a mess. Learn from my dumb experiences.

12. Let the oil drain for as long as you can. One hour is sufficient to drain almost all the oil.



13. I must mention here that I love the smell of gearbox oil. This has nothing to do with the procedure but what the hell I said it anyway!

14. Now your oil is probably all drained. I now clean the threads and magnets on the OLIO CAMBIO drain plug and replace it, along with the transfer case drain plug. It is recommended to use a new copper washer. I have heard aluminum is good also. I use a fiber one as it lets me tighten the plug with some fudge room. With the metal washers any





tighter than tight is stripped! I have also heard that if you anneal the old washer it works like a new washer. This entails holding it over the stove burner until it turns red hot then letting it air cool. I think this makes it softer, but remember I am not a scientist! If I were, I would be paying a real expert to do all this!!! Note: If you use the fiber washer I have had some that were slightly loose when I went to change to oil, so if you use one use it at your own risk. Ferrari recommends a NEW copper washer each time the plug is fitted! I am sticking to the fiber ones! *Jonathan's note: new copper crush washers are available from all the usual Ferrari parts places for cheap money, like \$.25 each, so just buy 10 of them the next time you order parts. Pep Boys auto stores has them as well.* 

15. Now the fun part, adding the oil. I improvised an oblong funnel with a piece of hose attached to it to just fit into the transfer case fill hole and sit neatly above my ignition coils. I am sure there are a thousand ways to do this but after 10 different tries this is my suggestion as the most efficient

way. You can of course fill the gearbox from the side filler hole, but that is very stupid, needs more tools and is totally unnecessary. The transfer case has a small hole that leads to the main gearbox so filling it from the transfer case hole has two main advantages. 1. It fills the transfer case without having to resort to some kind of measuring cup etc. and 2. It is much easier. Anyway, I have bought 5 gallon buckets of the Agip gearbox oil and had a swell time shaking them to get the limited slip additive to mix correctly, only to have to hold the heavy pail at an awkward angle for a long time to pour the oil in getting down off my step stool to check every once and a while that the gearbox is full and that oil is flowing from the rear side overflow hole. I have recently found that Agip sells the same oil in 1 liter containers making it much less exciting but also much less a pain in the ass. Several famous Ferrari Service technicians have recommended the Swepco 201 80W-90 gear lube. It is non-synthetic and has a limited slip additive in it also. I have heard so many good things about this gear oil that I drained out some fresh AGIP to fill the gearbox up with the Swepco. I will let you know how it works. One friend who uses it says he can shift into second when cold and that since it is a blue color it is easy to determine what fluid is leaking, if you have that problem! You know the old joke if your Ferrari doesn't leak it is out of oil. Rolls Royce calls it



#### "controlled seepage"!

You continue to fill the transfer case fill hole until oil starts to run out of the rear vertical gearbox filler hole. After cleaning the rear drain plug now is the time to replace it with your appropriate washer. Don't get it to tight or you will strip the box (read here \$\$) or to loose and it will fall out. Go read Goldilocks and the Three Bears and you will find the right compromise. I always tighten it then give it one little extra umph. I use as short a ratchet, as I do not want to strip the threads.



17. That's about it. I usually spend about 4 hours (or 4 days depending on my mood) wiping everything off and cleaning everything accessible as that is the type of guy I am! Now you can check your clutch alignment hole (in early 308's), bleed your brakes or change your coolant, since you are already there!!

**Legal disclaimer:** I am not an expert just an experienced owner so the techniques and procedures I describe should be used with care and caution. Any damage incurred to vehicle, property or persons is the sole responsibility of the owner. Note: I have a sense of humor, you may not, please take this into account while reading this, as this is therapy for me!



#### Oil : Everything You Wanted to Know and More.

#### **Author : AEHaas**

#### About the author:

Dr. Haas is a physician and surgeon. He graduated from the University of Florida with a degree in biochemistry with honors. He studied motor oils since high school where he did independent studies on this topic. He studied the properties of viscosity.

When he was a general surgery resident in Chapel Hill he studied the flow mechanics of human blood. Today he continues his research by discussion of oil products with chemists in the field and chemists from the oil manufacturers.

He has personal racing experience in Formula Super Vee. He is his own Lamborghini and Ferrari as well as Mercedes mechanic.

#### Chapter One - Motor Oil 101

I think it is time to go over passenger car automotive engine oils in detail. I will be writing several articles to be published soon so I will try to get some of it out here. I feel this is a very general topic for all car owners on this board.

This is a very difficult topic to comprehend. Everybody including good mechanics think they are experts in this field but few understand engine oils. Most of what I hear is the opposite of the truth. It is however easy to see how people get mixed up as there is always some truth to the misconception.

Please forgive me if I am too wordy or even verbose at times. I will be redundant for certain. This will be in areas that people have to hear things over and over again to get it right. Some will never be able to understand these concepts unfortunately. I base my thoughts on those whom I have been listening to in various automotive chat rooms and discussion with mechanics. I will try to minimize technical terms and be somewhat vague rather than exact. I will round and average numbers to make the point simple rather than mathematically exact. Thickness has the same meaning as viscosity. Viscosity is a measure of the resistance of a fluid (liquid or gas) to flow. Fluids with high viscosity, such as molasses, flow more slowly than those with low viscosity, such as water. Again, I am trying to explain general principals as I know them.

The greatest confusion is because of the way motor oils are labeled. It is an old system and is confusing to many people. I know the person is confused when they say that a 0W-30 oil is too thin for their engine

because the old manual says to use 10W-30. This is wrong.

More confusion occurs because people think in terms of the oil thinning when it gets hot. They think this thinning with heat is the problem with motor oil. It would be more correct to think that oil thickens when it cools to room temperature and THIS is the problem. In fact this is the problem. It is said that 90 percent of engine wear occurs at startup. If we are interested in engine longevity then we should concentrate our attention at reducing engine wear at startup.

Oils are chosen by the manufacturer to give the right thickness at the normal operating temperature of the engine. I will say this average oil temperature is 212 F, the boiling point of water. On the track that temperature is up to 302F. It is important to realize that these are two different operating environments and require different oils.

I will discuss driving around town first. Everything I say will be based on these conditions. At a later time I will discuss track conditions. Everything I say will be as accurate as possible without looking everything up and footnoting. I am trying to be general not ultra specific.

One thing that is no longer important is the ambient temperature. Older automotive owner manuals often recommended one oil for the summer and another for the winter. This is still necessary for air cooled engines but is no longer a consideration in pressurized water cooled engines. These engine blocks are kept at around 212 F all year round. The oil is around the same temperature as well. This allows for a single weight oil all year round. Again, this is not the same as on the track where the coolant temperature is slightly higher and the oil temperature is much higher.

Please forget those numbers on the oil can. They really should be letters as AW-M, BW-N or CW-P. The fact that we are dealing with a system of numbers on the can makes people think that they represent the viscosity of the oil inside the can. The problem is that the viscosity of oil varies with its temperature. A "30" weight oil has a viscosity of 3 at 302 F (150 C) and thickens to 10 at 212 F (100 C). It further thickens to a viscosity of 100 at 104 F (40 C) and is too thick to measure at the freezing point of 32 F (0 C).

30 weight oil:

Temperature (F)....Thickness

302......3 212......10 104......100 32......250 (rough estimate)

The automotive designers usually call for their engines to run at 212 F oil and water temperature with an oil thickness of 10. This is the viscosity of the oil, not the weight as labeled on the oil can. I want to stay away

from those numbers as they are confusing. We are talking about oil thickness, not oil can labeling. This will be discussed later. Forget the numbers on that oil can for now. We are only discussing the thickness of the oil that the engine requires during normal operating conditions.

The engine is designed to run at 212 F at all external temperatures from Alaska to Florida. You can get in your car in Florida in September and drive zig-zag to Alaska arriving in November. The best thing for your engine would be that it was never turned off, you simply kept driving day and night. The oil thickness would be uniform, it would always be 10. In a perfect world the oil thickness would be 10 at all times and all temperatures.

If the thickness of oil was 10 when you got in your car in the morning and 10 while driving it would be perfect. You would not have to warm up your engine. You could just get in the car and step on the gas. There would be little wear and tear on you engine, almost none. Unfortunately the world is not perfect.

The night before when you drove home from work the car was up the the correct operating temperature and the oil was the correct thickness, 10. Over night the engine cooled to room temperature and the oil thickened. It is 75 F in the morning now (I do live in Florida). The oil thickness is now around 150. It is too thick to lubricate an engine designed to run with an oil having a thickness of 10.

It is time to introduce the concept of lubrication. Most believe that pressure = lubrication. This is false. Flow = lubrication. If pressure was the thing that somehow lubricated your engine then we would all be using 90 weight oil. Lubrication is used to separate moving parts, to keep them from touching. There is a one to one relationship between flow and separation. If you double the flow you will double the separation pressure in a bearing. The pressure at the bearing entrance is irrelevant.

In fact the relationship between pressure and flow is in opposition. If you change your oil to a thicker formula the pressure will go up. It goes up because the resistance to flow is greater and in fact the flow must go down in order for the pressure to go up. They are inversely related. Conversely if you choose a thinner oil then the pressure will go down. This can only occur if the flow has increased.

It seems then that we should all be using the thinnest oil money can buy. This is partly true. Let me use my 575 Ferrari Maranello as an example. I drive this car around town. The manual of this car states the target pressure is 75 PSI at 6,000 RPM. The gold standard is that all engines should have a pressure of 10 PSI for every 1,000 RPM of operation, not more, not less. After all, you do need some pressure to move that oil along, but only enough pressure, not more. More pressure is not better, it can only result from the impedance of oil flow. Remember that oil flow is the only thing that does the lubricating.

Note that Ferrari is not saying what thickness of oil to use. That can only be determined by experimentation. My engine oil temperature is running around 185 F as I drive around town on a hot Florida summer day. I have found that the thinnest oil I can buy that is API / SAE certified is Mobil 1's thinnest oil. Even with this oil I get 80 PSI at 2,000 RPM. It is too thick for my application yet it is the thinnest oil money can buy. If I was on a hot Florida track in mid-summer the oil temperature would probably get up to 302 F. I will guess that the pressure would only be 40 PSI at 6,000 RPM. The oil I am using would not meet the requirement of 75 PSI at 6,000 RPM from Ferrari. I would have to choose a thicker oil for this racing situation. The oil I use now would be too thin at that very high temperature. (This is only partly true. Higher RPM running engines use thinner and thinner oils to get more and more flow. I will discuss this later).

High flow does more than lubricate. It is one of the things used to cool the hottest parts of your engine, the pistons, valve areas and bearings. This cooling effect is as important as lubrication in your engine. If your engine is running hot use a thinner oil. The flow will increase and so will the cooling. This is even more important in the racing condition.

Let us go back to the Ferrari manual. My older 550 Maranello only specified 5W-40 Shell Helix Ultra as the oil to use in all conditions. This car was designed for racing. As it turns out Ferrari now recognizes that not every owner races their cars. The newer 575 manual now states to use 0W-40 for around town situations even though Shell does not make this oil in the Helix Ultra formulation at this writing. They also recommend the 5W-40 by Shell if you insist on the Shell product. It is also the recommended oil for most racing conditions.

Ferrari recommends Helix Ultra Racing 10W-60 "for hot climate conditions racing type driving on tracks". Note that they now realize the difference between the daily urban driver like me and the very different racing situation. These are widely different circumstances. I want to emphasize that they only want you to use this oil while racing in "hot climate conditions". If you are racing in Watkins Glen up north use the 5W-40. If you are racing in Sebring in the middle of the Florida summer use the 10W-60. Around town in any climate, use the 0W-40.

It is time to dispel the notion that 0W-30 oil is too thin when our manual calls for 10W-30. A 0W-30 is always the better choice, always. The 0W-30 is not thinner. It is the same thickness as the 10W-30 at operating temperatures. The difference is when you turn your engine off for the night. Both oils thicken over the evening and night. They both had a thickness, a viscosity of 10 when you got home and turned your engine off. That was the perfect thickness for engine operation.

As cooling occurs and you wake up ready to go back to work the next day the oils have gotten too thick for your engine to lubricate properly. It is 75 F outside this morning. One oil thickened to a viscosity of say 90. The other thickened to a viscosity of 40. Both are too thick in the morning at startup. But 40 is better than 90. Your engine wants the oil to have a thickness of 10 to work properly. You are better off starting with the viscosity of 40 than the honey - like oil with a viscosity of 90.

I repeat: More confusion occurs because people think in terms of the oil thinning when it gets hot. They think this thinning with heat is the problem with motor oil. It would be more correct to think that oil thickens when it cools to room temperature and THIS is the problem. In fact this is the problem.

This is the end of lesson number one.

aehaas

#### Motor Oil 102

Chapter two. It gets more difficult.

We left off discussing that a 0W-30 weight oil is not thinner than a 10W-30 oil. They both have the same thickness at operating temperature. The 0W-30 simply does not get as thick on cooling as the 10W-30. Both are still way to thick to lubricate an engine at startup.

I have heard several people say that Porsche specifically prohibits a OW-XX engine oil, that it is too thin. Now here is the partial truth I spoke of earlier. We will discuss multigrade oils. Earlier we said that a straight 30 weight oil has a thickness of 10 at the normal operating temperature of your engine. The multigrade oils OW-30 and 10W-30 also have a thickness of 10 at 212 F.

The difference is at 75 F, your startup temperature in the morning.

Oil type... Thickness at 75 F...Thickness at 212 F

Straight 30	250	.10
10W-30	.100	10
0W-30	.40	.10

Straight 10...... 6

Now you can see that the difference between the desired thickness your engine requires ( = 10 ) is closest to the 0W-30 oil at startup. It is still too thick for normal operation. But it does not have far to go before it warms up and thins to the correct viscosity. Remember that most engine wear occurs at startup when the oil is too thick to lubricate properly. It cannot flow and therefore cannot lubricate. Most of the thick oil at startup actually goes through the bypass valve back to the engine oil sump and not into your engine oil ways. This is especially true when you really step on that gas pedal. You really need more lubrication and you actually get less.

Note that a straight 10 weight oil is also too thick for your engine at startup. It has a thickness of 30. Yet at operating temperatures it is too thin having a thickness of 6. It needs to be around 10. The oil companies have added viscosity index improvers or VI to oils to solve this dilemma. They take a mineral based oil and add VI improvers so that it does not thin as as much when it gets hotter. Now instead of only having a

thickness of 6 when hot it has a thickness of 10, just as we need.

The penalty is the startup thickness also goes up to 100. This is better than being up at 250 as a straight 30 weight oil though. Oil with a startup thickness of 100 that becomes the appropriate thickness of 10 when fully warmed up is called a 10W-30 weight motor oil. This is NOT as thick as a straight 30 weight oil at startup and it is NOT as thin as a straight 10 weight oil at full operating temperature.

The downside of a mineral based multigrade oil is that this VI additive wears out over time and you end up with the original straight 10 weight oil. It will go back to being too thin when hot. It will have a thickness of 6 instead of 10. This may be why Porsche (according to some people) does not want a 0W-30 but rather a 10W-30. If the VI wears out the 0W-30 will ultimately be thinner, a straight 0 weight oil. When the VI is used up in the 10W-30 oil it too is thinner. It goes back to a straight 10 weight oil. They are both still too thick at startup, both of them. The straight 0 weight oil, a 5 weight oil and a 10 weight oil are all too thick at startup.

This is just theory however. With normal oil change intervals the VI improver will not wear out and so the problem does not really exist. In fact, oils do thin a little with use. This is partly from dilution with blow by gasoline and partly from VI improvers being used up. What is more interesting is that with further use motor oils actually thicken and this is much worse than the minimal thinning that may have occurred earlier.

Synthetic oils are a whole different story. There is no VI improver added so there is nothing to wear out. The actual oil molecules never wear out. You could almost use the same oil forever. The problem is that there are other additives and they do get used up. I suppose if there was a good way to keep oil clean you could just add a can of additives every 6 months and just change the filter, never changing the oil.

When the additives wear out in a synthetic oil it still has the same viscosity. It will not thin as a mineral oil. The fear that some say Porsche has that oils thin when the VI runs out is not applicable to these synthetic oils. These oils will always have the correct thickness when hot and will still be too thick at startup as with all oils of all types, regardless of the API / SAE viscosity rating.

Automotive engine manufacturers know these principals of motor oils. They know there is thinning or thickening that will occur. They take these things into account when they write that owners manual. Mineral oil change recommendations will generally include shorter time intervals than those of synthetic oils.

The reality is that motor oils do not need to be changed because they thin with use. It is the eventual thickening that limits the time you may keep oil in your engine. The limit is both time itself (with no motor use) and/or mileage use.

End of part two.

aehaas

#### Motor Oil 103

Part Three. You have a synthetic mind.

Let us compare mineral and synthetic oils. I will not talk about chemical but rather functional differences. We discussed before how mineral oils are too thick at startup yet too thin when hot. The viscosity was corrected with the hot engine by adding VI improvers.

A 10W-30 multigrade mineral based oil is made from a 10 weight oil and has VI improvers added to thicken the product in a 212 F engine. It acts as a 30 weight oil when hot. It acts more as a 10 weight oil at startup. I remind you that a 10 or 5 or 2 weight oil is still too thick to provide lubrication at startup. They are all too thick at startup. There is currently no engine oil thin enough to operate correctly at startup. They all cause excessive wear at startup. Again, we are discussing the needs of my single hypothetical engine for around town driving.

Oil type.. Thickness at 75 F .. Thickness at 212 F

Straight 30	.250	.10
10W-30	.100	10
0W-30	.40	.10

Straight 10	30	6
Straight 5	20	4
Straight 2	15	3
Straight 0	12	3 est.

A 10W-30 synthetic oil is based on a 30 weight oil. This is unlike the counterpart mineral oil based on a 10 weight oil. There is no VI improver needed. The oil is already correct for the normal operating temperature of 212 F. It has a thickness of 10 while you drive to work. It will never thin yet has the same long term problem as the mineral based oil. They both thicken with extended age.

Synthetic oils are derived in the laboratory. They are pure, usually nearly clear. I describe mineral based motor oils as a distilled, concentrated product. The impurities need to be removed from the raw petroleum. These oils are therefore less clean and contain many impurities. Again, the problem is really more of theory than practice but the difference does exist.

People repeatedly say that synthetic oils are more stable in a hot engine. I hear that they lubricate better. The answer is yes and no. Oil molecules do not break down, just the additives. Generally, the synthetic oils do not have VI improvers so have less to lose.

There are some properties of synthetic oils that actually result is less wear than with mineral oils. These help

increase your gas mileage as well. Due to a reduction of internal friction of the synthetic oil your engine will run a bit cooler. Wear increases as temperature increases, all other things being constant.

A main advantage that the synthetic has over the mineral based oil is the ability to lubricate at startup. Both types of oil have the same specifications at 104 F, 212 F and 302 F. It is the startup viscosity characteristics that separate these oils. Synthetic oils do not thicken as much on cooling. They have better fluidity as the temperature drops.

A synthetic oil that is labeled as 10W-30 is less honey like as a mineral based 10W-30 motor oil at startup. They both have a thickness of 10 at normal operating temperatures. At 75 F the synthetic is not as thick. At 32 F the difference between the two is even greater. At 0 F the mineral oil is useless yet the synthetic works fairly well. Just keep the RPM to a minimum.

At temperatures below zero you will not be able to start your car with mineral oils while the synthetic oils may be used to -40 or - 50 F. Oils are so thick that the normal method of viscosity measurement is not possible. Instead we measure if the oil can even be pumped or poured. Again, we are only discussing a single category of oil, the multigrade 10W-30 API / SAE grade.

I took an except from the web about Mobil 1 oils. They compared a 5W-30 synthetic Mobil 1 oil to a mineral based 10W-30 and a 10W-40 in ice cold conditions. The engine turned over at 152 RPM with the synthetic 5W-30 Mobil 1. The 10W-30 and 10W-40 mineral oils turned over at 45 and 32 RPM respectively. Neither of those engines started.

Motor oil becomes permanently thicker with exposure to northerly winter type weather. This is more of a problem to mineral based oils. Waxes form. This is why it is a bad idea to even store a bottle of oil in a cold garage. It goes bad on the garage self just because it is exposed to the cold.

To recap, synthetic oils have similar characteristics as mineral oils at operating temperatures. The synthetic oil will however be less honey - like at startup even though it has the same API / SAE rating. Yet the synthetic 10W-30 weight oil is based on a heavier 30 weight oil while the mineral based 10W-30 oil is based on a thinner 10 weight oil. They are both similar at operating temperatures yet the 30 weight based synthetic is actually less thick at startup and much less honey - like at low temperatures. This is the opposite of what common sense dictates.

This is worth repeating: The synthetic 10W-30 weight oil is based on a heavier 30 weight oil while the mineral based 10W-30 oil is based on a thinner 10 weight oil. They are both similar at operating temperatures yet the 30 weight based synthetic is actually less thick at startup and much less honey - like at low temperatures. This is the opposite of what common sense dictates.

As one can see this is no easy topic. Are you with me?

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#### Motor Oil 104

Part Four. It is not what we thought.

Now let us finish talking about the differences of mineral verses synthetic oils. I will compare the same weigh or grade of oils showing that the operating viscosities are the same whereas the startup viscosities vary:

Mineral oil:

Oil type...Thickness at 75 F... at 212 F...at 302 F

Straight 30	250	10	3
10W-30	100	10	3
0W-30Tl	here are no	ne in this range	e

Synthetic oil:

Oil type...Thickness at 75 F... at 212 F...at 302 F

Straight 30	100	10	3
10W-30	75	10	3
0W-30	40		3

Since the synthetic oil thickens less on shutdown your startup will be easier and so will the stress on your engine. This is perhaps the best thing the synthetic class has over the mineral based oils.

People sometimes use a thicker oil to minimize gasket leaks. This seems obvious to me. Repair the gasket. Do not destroy your engine with an oil that is too thick for proper function.

Some people have said they use thicker oils because they only use their cars every 2, 3 or 4 weeks. They are afraid that thin oils will fall off the engine parts and result in a lack of lubrication at startup. Think about your lawn mower over the winter. I gets gummed up solid. The oil and fuel thicken over time resulting in engine failure. Anyway, oil on the surface of parts does not lubricate. It is the FLOW of oil between parts that lubricates. Thick, old, waxy oil can only be bad.

I have seen several car owner manuals that are now stating that oils do not need to be changed but every

7,500 miles or more. The same manual also states OR every 12 months, whichever occurs first. My feeling is that you can probably go 5,000 miles on the average (in a sports car) but you must change your oil in the spring time at a minimum, particularly up north. Oils form waxes in icy cold weather. There is a permanent thickening of the oil.

Some automotive manufacturers are backing down on oil change intervals to 5,000 miles or less and some advocate changing the oil at least every 6 months as well. I think this is because of the tendency for oils to thicken in very hot engines (not ambient conditions, just hot engines). Also because of thickening from the cold of winter and from sludge build up that cannot be filtered out.

I truly believe that oil is much better being too thin than too thick. Over the years we have been going to thinner and thinner oils despite hotter engines with turbos and the like. The tendency is that people figure they need a 40 weight oils but then use a 50 instead. Better thinking is that if you think you need a 40, use a 30 weight oil instead. I firmly believe this based on all I know about oils.

As it turns out synthetic oils do cling to parts better as they have higher film strength than mineral oils. Synthetics are thinner overall. They have greater slipperiness. Yet they stick better to engine parts. Again, this concept is the opposite of normal thinking.

The thickness of moving oil is measured in centiStokes or cS. Most engines want the oil viscosity to be around 10 cS at normal operating temperature. The really thick multigrade oils have a viscosity of 20 cS at operating temperature. One is not twice as thick as the other, it is only 10 cS thicker.

As we increase the heat from 212 F to 302 F the most commonly recommended oil thins from 10 cS to 3 cS. The thicker oil drops from 20 cS to 4 cS. Note that in a very hot engine the difference between the two oils is now only 1 - 2 cS. In other words they have about the same thickness. There is little advantage to a thicker based oil as a 20W-50 at very high temperatures. No, the 4 cS oil is not twice as thick as the 2 or 3 cS oil. This difference is almost insignificant.

There is a huge advantage of using the thinner, 10W-30 at startup where 90 percent of the engine wear occurs. At 75 F the thicker oil has a viscosity in the range of 250 cS while the thinner oil has a viscosity of 100 cS. The thicker stuff is 150 cS thicker. This is a very big difference. I am using the 20W-50 as my thicker oil example here.

People are always asking about adding things as Slick 50 into the oil tank. Do not do this. The oil companies and engine manufacturers work together very hard to give you the product you need. Engines are running hotter, longer with more BHP from less CID. Smaller, more efficient engines are getting us more MPG and yet better acceleration. These engines last longer and are more reliable.

Part of that reason is the nature of the lubricants. There is a lot of competition to get us the best working motor oil. Independent additives cannot make the oil better and in many cases makes things worse. There

have been engine failures as a result of adding some of these aftermarket additives to motor oil.

Motor oil that is labeled for RACING ONLY is not usable for every day driving. Often these have more additives that are toxic to your catalytic converters and the environment. These oils generally do not have detergents. These are very important for your engine unless you plan on taking it apart every few weeks and cleaning every single surface. The oils do not meet the API / SAE requirements for ratings as SJ, SL or now SM.

You do not need to use the exact oil type and brand that your car manual tells you to use. Oils are pretty general. They are not that different. Ferrari is married to Shell. If you call them up and ask to use Valvoline instead they will tell you that they have not tested that brand in their cars. They only tested the engine with Shell oils. They cannot comment on the performance of other oils in their engines. This is a fair statement. The reality is that the Shell and Valvoline oils of the same specification (viscosity, API and SAE ratings, synthetic or not) are very similar. (I do have my bullet proof vest on ).

People often say that their old 1980 car manual says to use a specific Brand-X motor oil. They keep trying to locate these older oils. First, just about any oil brand that meets the original specifications will do. Second, all oils are much, much better now. They are all much better. One could say that synthetic oils are better than mineral oils but is is hard to say that one brand is that much better than any other. Personally, I do stick to the big names. It does not mean that small motor oil companies are not as good. They could be better for all I know.

Using an oil that is less thick at startup has other benefits. Let us compare a synthetic 10W-30 to a mineral based 10W-30. Both give you a viscosity of 10 cS at normal engine operating temperatures. They both thin to 3 cS at high temperatures. At 75 F tomorrow morning the story will be different. The startup viscosity of the synthetic will be 50 whereas the mineral based 10W-30 will be 75. Again, both are too thick at startup but the synthetic will cause less startup time period wear and tear. You will get a little better gas mileage too.

The synthetic lubricated engine will turn over easier. This has the effect of using less power from your starter motor. It will last longer. Your battery has less of a current draw. This will also last longer. The battery was discharged less during the start so the alternator will rob less power from your engine to recharge. The alternator lasts longer and you get a little better gas economy. The only downside of synthetic lubricants is the cost. They cost 2 or 3 times as much as mineral based oils. Never-the-less I use plain Pennzoil multigrade mineral based 5W-20 in my Ford Expedition. This oil is thin enough at startup to have many of the attributes I just mentioned.

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#### Motor Oil 105

Part Five. Let's use top gear:

Let's go racing. I will discuss driving in traffic jams in the Florida summer as well as racing in Sebring though there is no commonality. People lump these two driving situations together but there is no overlap.

On the race track one usually uses all the BHP their engine can give them. You briefly step on the brakes for the corner then put the pedal to the metal the rest of the time. Your oil will get up to 302 F, but your cooling system is around 212 F. The engine produces tremendous heat but can only pass it off so fast to the cooling system. There is a lot of air moving past the cooling radiator so the antifreeze / coolant is able to get rid of the extra heat from this part of the system with relative ease.

The temperature of oil on your gauge is not as hot as it really gets. This temperature is an average with oil from different parts of the motor. Some parts are hotter than others. It is said that some of the oil gets as hot as 400 or 500 F in these racing situations.

In an earlier section I said that thicker oils are usually needed in racing situations but not necessarily. Remember that a major function of oil is to cool the inside of your engine. In ASTM D 4485 3.1.4: "Terminology: Engine oil- a liquid that reduces friction and wear between moving parts within an engine, and also serves as a coolant." Since the oil with a viscosity of 10 cS at 212 F thins to a viscosity of 3 cS at 302 F we will get more flow. The pressure will go down some as well. This is OK as long as we have a minimum of pressure to move the oil.

This increased flow will result in increased cooling by the oil. This is a good thing. You would probably want more oil flow in these situations and you get it. The hotter oil thins and this increases flow. The higher flow works harder to separate the engine parts that are under very high stress. It all works out for the better. Higher revving engines need thinner oils. You do not necessarily need to go to a thicker oil while racing. Only experimentation will tell.

The best way to figure out what viscosity of oil you need is to drive the car in the conditions you will use. Then use the oil viscosity that gives you 10 PSI per 1,000 RPM under those circumstances. For some reason very few people are able to get this simple principal correct. I cannot explain further.

These same rules apply to engines of any age, loose or tight. Just because your engine is old does not mean it needs a thicker oil. It will need a thicker oil only if it is overly worn, whether new or old. Yet the same principals of 10 PSI per 1,000 RPM still apply. In all cases you need to try different weight oils and see what happens. Then choose the correct viscosity.

I am using 0W-20 in my Ferrari 575 Maranello right now. It has over 5,000 miles on the clock. There will be a day (my estimate is 50,000 miles) when I will have to go to a 0W-30. In the future I will have to increase the viscosity to a 0W-40, then a 0W-50, maybe. I will use whatever it takes to give me 75 PSI at 6,000 RPM during the lifetime of my engine. This formula works in all situations.

Some people have tried this and occasionally get a somewhat low oil pressure while at idle. This is fine. There

is no stress on parts at idle, the smallest oil flow will do the trick. It is at higher RPM where more BHP is produced. This is where we need the flow. Remember that Ferrari uses 75 PSI at 6,000 RPM as the place to test your oil viscosity needs. If your oil gives this value under your driving conditions then your lubrication system has been maximized. Period.

Do not go 5,000 miles with the same oil if you are racing your car. You should change the oil every 1 or 2,000 miles. If you drive your car around town then you need to change the oil for that situation. Use racing oil on the track and urban oil around town. The best situation as described by Ferrari is to use the 0W-40 around town and the 10W-60 "racing oil" on the track. It has to be that "hot" track though. A compromise situation would be to use the 5W-40 for both but this may not be optimal. Certainly, if you are just an urban driver as me use the 0W-40 or even a thinner oil as I do in my Maranello. Again, I use the 0W-20.

FYI. The Formula 1 cars that run at 15,000 RPM and higher use straight 5 and 10 weight oils.

Now let me discuss what people think is a similar situation to racing. That is hot summer traffic jam driving. Your car should be able to handle this. If you have problems then you have a problem with your car, most likely in need of a cooling system overhaul.

When you drive that car down the road mid-winter in upstate New York or mid-summer in Florida the engine and oil temperatures will be around 212 F. But your Florida vacation is suddenly altered by a hurricane. You have to get out of Tampa, but so do a million other people. It is now 95 F and you are in a snarl. Everyone thinks they need a thicker oil for this situation. This is false.

Your engine is not producing much heat at low RPM and low BHP output. The production of heat is relatively slow. It can easily be transmitted to your cooling system. The problem is that your cooling system has trouble getting rid of the heat. The oil and the coolant will slowly rise in temperature. They both rise together. The increase is no big deal for your oil. It goes to 220, then 230 F. The problem is that the cooling system can only handle heat up to 230 F. After that you overheat the cooling system and the car must be shut off. The oil never got that hot, It was just that the water got a little hotter than its system design.

You now see that overheating in traffic is a cooling system problem and not an oil system problem. Do not change to a thicker oil based on your traffic situation.

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#### Motor Oil 106

Part Six. A personal recommendation. (Updated in 2007)

These are the motor oils I recommend. This is based on information that I just happened to collect. I have not gotten the specifications of all oils out there. My opinion on these oils is based on viscosities. By this I mean

less honey like at start up temperatures and appropriate for the required viscosity at operating temperature. I broke it down to several classes, 1-Fully Synthetic, 1.2-Race Track, 2-Semi-Synthetic, 3-Mineral (dinosaur) oils. The asterisk is my preferred from each group of very similar products. And these are usually easier to find in my experience. Remember, all oils are too thick at start up. There is no such thing as an oil that is too thin below 100 F. The thinnest motor oil made is still too thick at start up temperatures.

It seems that many engines work best with a multigrade 30 weight oil. Others would do better with a 20 weight oil and few would require a 40 weight oil. You can only determine what is best by experimenting. Admittedly I did not think my Ferrari Maranello would need a 20 weight oil. In truth I could actually use a 10 weight oil. A 0W-10 would be good but it simply does not exist for normal use. Red Line does make 2W, 5W and 10W oils (this acts as a 0W-10 multigrade oil) but they are for racing only. One Formula 1 team has actually used these very oils off the shelf from Red Line.

.....Synthetic Class.....

60 wt: Agip Synthetic PC 20W-50 (a thick 50 wt oil) Redline straight 60 wt racing oil (racing only, acts as a SAE 20W-60 oil)\* Shell Helix Ultra Racing Oil 10W-60

50 wt: Castrol Syntec 5W-50 Penn Synthetic 5W-50 Red Line 15W-50\* Shell Helix Ultra 15W-50

40 wt: Amsoil 0W-40 Castrol European Formula 0W-30 (a thicker 30 wt oil, almost a 40 wt oil)\* Mobil One 0W-40

30 wt: Mobil One 0W-30 Penn Synthetic 5W-30 Red Line 5W-20 (a thick 20 wt oil)\*

20 wt: Mobil One 5W-20\* Valvoline SynPower 5W-20

.....Race Oils for Street Use.....

Use these when continued sump temperatures over 240 F are expected.

60 wt: Redline straight 60 wt racing oil (racing only, not for the street, acts as a SAE 20W-60 oil) Shell Helix Ultra Racing Oil 10W-60 Valvoline SynPower 20W-50

50 wt: Castrol Syntec 5W-50 Shell Helix Ultra 15W-50

40 wt: Red Line 5W-40 Shell Helix Ultra 5W-40

30 wt: Red Line 10W-30

20 wt: Amsoil 5W-20 Red Line 5W-20

.....Synthetic Blends.....

60 wt: Castrol Syntec Blend 20W-50

50 wt: Valvoline 20W-50

40 wt: Agip 4-Synt 10W-40 Valvoline Durablend 10W-40\*

30 wt: Castrol Syntec Blend 5W-30 Motorcraft Blend 5W-30 Valvoline Durablend 5W-30\*

20 wt:

Motorcraft 5W-20\* Valvoline Durablend 5W-20

.....Non-Synthetic.....

50 wt: None recommended - all relatively too thick at start up.

40 wt: Penn regular Multigrade 10W-40\* Valvoline All Climate 10W-40

30 wt: Penn regular Multigrade 5W-30\* Valvoline All Climate 5W-30

20 wt: Penn regular Multigrade 5W-20 Mobil Clean 5000 5W-20\*

If while on the road you are forced to add oil there are rules. Let us say for example that our engine has synthetic Mobil One 0W-30. Use the same type and brand if you can. If you are using Mobil 1 then it is acceptable to mix different grades but use a close grade when possible. It is not a good idea to mix say 1/2 your oil tank with 0W-30 and 1/2 with 15W-50 Mobil 1. If there is no Mobil 1 available then use the mineral based Mobil oils next,.

The last choice is to mix a synthetic of another brand. They should not react adversely if mixed but it may dilute additives. This is not a good combination. Use this combination if you must but only until an oil change can safely be performed some time soon.

I personally used 0W-20 Mobil 1 in the 575 Maranello and for the first oil change I drained the Murcielago's (OEM) 5W-40 Agip and replaced it with 0W-30 Mobil 1. The engine became much quieter. A valve tappet noise disappeared. I am now using the 5W-20 Red Line in the Lamborghini. Used oil analysis shows that this oil works well for my non racetrack application. The same oil went into my Maybach 57. My Enzo Ferrari calls for the Shell Helix Ultra racing 10W-60 but I am using the Castrol Syntec European Formula 0W-30. This is different than the easy to find plain 0W-30 Syntec. It MUST say European Formula across the front of the label. I buy it at AutoZone stores but it is often mixed with the plain stuff.

You have to try by experimentation what operating oil grade your engine requires. In all cases however, you want the oil that gets least honey-like at startup and thins to the appropriate thickness for normal operation. Always recheck the oil label as they change a lot.

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#### Motor oil 107

Chapter Seven. What is the terminology from SAE and API.

Many think that the "W" in 10W-30 means "winter".

From SAE J300 p.2:

"Two series of viscosity grades are defined in Table (1): (a) those containing the letter W and (b) those without. Single viscosity grade oils with the letter W are defined by maximum low temperature cranking and pumping viscosities and a minimum kinematic viscosity at 100C. Single grade oils without the letter W are based on a set of minimum and maximum kinematic viscosities at 100C and a minimum high shear rate viscosity at 150C. The shear rate will depend on the test method. Multigrade grade oils are defined by both of these criteria....

The W is just a designation of one type of testing vs another.

What is the viscosity of the various weight oils? The definitions are as follows:

From SAE J300, viscosities at 212 F...

20, range - 5.6 to 9.2 30, 9.3 - 12.4 40, 12.5 - 16.2 50, 16.3 - 21.8 60, 21.9 - 26.1

By a modified analysis the min. viscosity at 302 F...

20, 2.6 30, 2.9 40, 2.9 - 3.7 50, 3.7 60, 3.7

Note again that the difference between the 20W and 60 weight oils at 302 F is only about 1 (one). Whereas the difference in viscosity at 104 F is 120 units. The 20W has a viscosity of 40 and the 60W a viscosity of 160. The difference at startup is even higher, probably 250 or 300.

The American Petroleum Institute, API, and Society of Automotive Engineers, SAE, have rated engine oil

performance over the years. We have seen the ratings go from SA, SB, SC, SD, SE, SF, SG, SH, SJ, SL with SM to follow. SI and SK were eliminated as they are used by other businesses. There are over 3 dozen tests that oil now must pass in order to make the next higher rating. The tests are defined by the American Society for Testing and Materials, ASTM. Some tests have progressed to a zero tolerance level. For example there can be no sticking of any piston rings any more. I will compare the SL rated oil to the previous SJ oil in a few categories. For simplicity I will skip the units of measurement:

.....S J.....S L.....

- ......30.......20......maximum cam plus lifter wear
- ......9......7.8.....sludge build up
- ......5......8.9.....varnish rating (more is better)
- ......60......45......high temperature deposits
- ......17......10......high temperature volatility

Other categories include: Resistance to rust, resistance to foaming, resistance to oil consumption, homogeneity and miscibility, flow reduction with varying amounts of absorbed moisture, gelation index and others.

As one can see just going from the previous SJ to the current SL rating is a significant improvement. I cannot wait to get the upcoming SM oil into my cars.

Regarding cool whether gel formation, a small except from SAE j300 1999:

4. Because engine pumping, cranking and starting are all important at low temperatures the selection of an oil for winter operation should consider both the viscosity required for oil flow as well as cranking and starting, at the lowest expected ambient temperature.

Pumping viscosity is a measure of an oils ability to flow...during the initial stages of operation. Test in ASTM D 4684. ....samples are tested after a slow cool cycle. This cycle has predicted as failures several SAE 10W-30 and 10W-40 oils which are known to have suffered pumping failures in the field after short-term (2 days or less) cooling. These field failures are believed to be the result of the oil forming gel structures that result in excessive yield stress and viscosity of the engine oil...

A.2.1...After preliminary warming, the sample is subjected to a controlled temperature/time cycle over 5 1/2 to 7 days. The cycle reproduces ...instability or reversion which has occurred during storage of oils in moderately cold cyclic conditions. Recent work shows relevance to engine oil pumpability failure. Oils exhibiting pour reversion have solids resulting from wax gel formation, at temperatures significantly higher than their ASTM D 97 pour points.

Extracted, from ASTM D 4485-03 Standard Specification for Performance of Engine Oils, copyright ASTM International, 100 Barr Harbor Drive, Wets Conshohocken, PA 19428, USA.

My point is that tests are not just laboratory concoctions. They design tests to match real life conditions.

I use 5W-20 Pennzoil mineral based multigrade oil in my Expedition as it has many of the low temperature characteristics of higher weight synthetic oils. My '04 manual states that the SUV is delivered with a Ford semi-synthetic oil and although regular oil can be used they recommend a semi or full synthetic oil. For the differential gear oil they used 75W-140 in my '98 Expedition but now recommend 75W-90.

Please note that it makes no difference what oil you are using. The OW-20 Mobil 1 that is SL rated meets the same criteria as that SL rated 10W-30 synthetic or mineral based Pennzoil. That SJ or in particular that SH oil some people are looking for (from their older automotive owners manual) is no where near as good as any SL oil of today. Always use the most currently available, highest rated motor oil, even in the oldest, most worn engine. You may require a thicker grade but just make sure it is SL rated.

The SH rating was used in oils starting 1993. The SJ rating started in 1997 while the SL became effective in 2001 oils. According to ASTM D 4485, SL rated oils are superior to previous oils and from: X2.3.1 and 2: SL oil is for use in current and all earlier passenger cars, sport utility vehicles, vans, and light trucks. This SL rated oil can be used in engines requiring SJ and all earlier categories.

See: American Society for Testing and Materials- <u>www.astm.org</u> ......Society of Automotive Engineers- <u>www.sae.org</u> ......American Petroleum Institute- <u>www.api.org</u>

#### Motor Oil 108

Chapter Eight. Odds and ends.

I have some stories that I collected. First, my architect drives a big SUV. He was running with Mobil 1 brand 15W-50. He changed it to Pennzoil Multigrade (mineral oil based, non-synthetic, cheap) 5W-20 at my suggestion. His gas mileage went from 10 to 13 MPG around town. What really impressed him the most was the "robust" increase in "get up and go." He changed from a thick synthetic to a thin mineral oil. His venue is stop and go city traffic in Florida, mostly short trips. The oil just never got that hot to require a 50 weight oil. Short trips means that the oil temperature never gets up to the normal operating range. It was too thick on short trips and too thick when it did get up to temperature.

The lower temperatures he was seeing occurred because of reduced friction and internal drag and higher oil flow.

One of the members of the Ferrari Chat web site went from a 40 to a 30 weight oil in his Ferrari 355 for racing in Texas. He noticed a drop in temperature but no change in oil pressure. This may seem odd but really makes perfect sense. Since the 30 weight oil is thinner he got better flow and therefore better cooling. The oil was at a lower temperature so it was not as thin than it would have been at the previous higher temperature.

Cooler engines last longer. Fact: The higher the temperature, the greater the wear, all other things being equal.

People say that their old car manual says to use a 10W-40 so they would never think of using a 0W-40. Again, both are the same viscosity at normal engine operating temperature. The 0W-40 just does not thicken as much after you turn off your engine. There are now several cases when manuals for older cars have been updated to reflect this. My 550 Ferrari Maranello manual said to use 5W-40 yet the 575 manual says to use the 0W-40. The engines are the same except the 575 has more BHP. It has better acceleration and more top speed. The engines have the same tolerances.

All manufacturers I have seen are specifying 0W-XX or 5W-XX oils now. Honda, Ferrari, Ford, Mercedes, Porsche, and others specify a 0 or 5W-XX oil to mention a few. These are appropriate for all engines of all ages of all levels of wear. This second number is the only thing that may change with an older, lose or worn engine. This can only be determined by experimentation. If you are using XW-50, go to a 0W-40. If your pressures are still too high go to a 0W-30 and so on.

When I took delivery of my 575 Maranello I drove for 500 miles then changed the oil to 0W-30 Mobil 1. There were no changes in operating pressure or temperature. Starting the engine seemed faster though. I called up FNA and was told that all new Ferrari cars are delivered with 5W-30 Shell Helix Ultra. That is when I decided to try the 0W-20 Mobil 1. I could even go to a 10 weight oil as my pressures are still excessive while driving around town. I do not drive on the track.

What about the break in period? For one thing you could just follow the car's manual and gradually break your engine in. Some cars like Ferrari and Lamborghini run engines and the cars for a period of time before you even take delivery. They often run up to full power. Some representatives at least from Ferrari hinted that the traditional break in period was not really needed, at least in their car.

Most people who buy high powered cars that I have experienced will just get in there cars and step on the gas fully. They do not wait for the oil to warm up. Personally I would not mind running full BHP for short bursts during the break in period but I always fully warm up the engine first.

Older engines may in fact benefit from thinner oil use. Over time permanent deposits of carbon and sludge build up in the engine oil ways. It is like a clogging of arteries in humans. We are now all on blood thinners. This is an area I specifically studied while a general surgeon resident at Chapel Hill.

Thinner oils, and specifically synthetic products are better. Some people say their engines were "designed" to run on mineral based lubricates. I have not seen anything to support this theory. The synthetic of the same viscosity as the mineral oil you are now using will be an improvement. If you go from a mineral to an even thinner synthetic you may be better off still. The pressures go up in many older engines because of this "clogging" of the arteries. Most think this is good but it is really a lessening of flow and therefore accelerates engine wear even further.

For those engines with excessive varnish and carbon buildup the engine oil additives of the detergent type may be of benefit. On the other hand you could just use a thin synthetic oil and change it every 200 miles for a while and end up with an even cleaner engine. With everything working properly you may actually need a thicker oil if that engine is overly worn. The thicker oil would be a disaster however, if the arteries were narrowed from deposits.

Remember, the only difference between a 0W-40 and a 10W-40 is that the 0W-40 thickens less after you turn off your engine. It is still too thick in the morning at startup but not as thick as the 10W-40. Yet, they are still too thick to use until they both warm up to operating temperature at which point they have the save viscosity, around 13 to 14. Remember that the 0W-30, 10W-30 and straight 30 weight oils all have a viscosity of around 10 at normal engine operating temperatures.

There is one more thing. A 20 weight oil is not half as thick as a 40 weight oil. The real scale is more like the oils having an absolute thickness of 108 and 114. Now it can be seen that the 40 weight oil is only around 10 percent thicker than the 20 weight oil. The difference is not that much at operation but at startup the difference is significant. Pressure / flow dynamics go along with this 10 percent figure. A 30 weight oil should be thought of as having an absolute viscosity of 110 and a 50 weight oil has an absolute viscosity of 120. I am talking about operating temperatures.

I thought everyone knew that 90 percent of engine wear occurs during the startup period because oil is just too thick. Some think it is good to have a thicker oil for startup since the parts shrink when cold and would otherwise "rattle." Sure, your piston diameter will shrink on cooling but so will the diameter of your bore. The net result is about the same clearance hot and cold. This is not true for your valves. They lengthen when extremely hot. In the Murcielago they use shims instead of self adjusting valve tappets. You need to put a millimeter of clearance there so that after expansion the valve will not be held partly open when it is supposed to be closed.

If it were true that thicker oils were needed at startup then the manufacturers would not be requesting oils that thicken less on cooling. They would just specify that one should use a straight 30 or 40 weight oil. Instead, over time, they are specifying thinner and thinner oils.

The manufacturers know what parts shrink or expand and the clearance changes that result. You do not have to worry about this. If it was that easy to design engines we would all be making them.

I would like to go back to the worry that oil falls off the parts when a car is stored or sees long periods of inactivity. For the first oil change in my 575 Maranello I drained the Shell and put in 0W-30 Mobil 1. This was at 775 miles on the odometer. I drove the car home from work, put it on the lift and drained the transaxle and engine oils. I also opened and drained the oil cooler and took off every line that is in the oil system. I wanted to get every speck of the Shell oil out of there. For optimal results you are not supposed to mix synthetic oils of different brands.

The system takes 12 quarts with a "normal" oil change but took 15 quarts for this change. It all took about an hour. I then started the engine to check for leaks. The multitude of mechanical engine noises that followed nearly broke my eardrums for about 10 long seconds. Then it was suddenly very quiet. You could hear a pin drop. There was certainly the most possible amount of surface oil on all the internal parts as the engine was only off for an hour. But it was not until the oil circuit primed, filled then sent flow into all the parts that any lubrication was occurring. Hence all oil filters that are manufacturer certified have back flow limiters to keep the oil filter full even with the engine off.

Here is an interesting tidbit of information. A 75W-90 gear oil has the same viscosity as a 10W-40 engine oil at 212 and 302 F. Once again, those numbers on that oil can are misleading and certainly add to the confusion I see among automotive enthusiasts. At 75 F gear oils are much thicker than motor oils. There are no start up issues so pour point depressants are not added that minimize the thickening with cooling in gear oils.

aehaas

#### Motor Oil 109

Chapter nine. Let's start over.

We have seen that 0W-30, 5W-30, 10W-30 and straight 30 weight oils all have the exact same viscosity at 212 and 302 F. What about startup viscosities? Do 0W-20, 0W-30, and 0W-40 all have the same viscosity at a 75 F startup. The answer is no. The SAE J300 standard allows for this discrepancy. Here are some examples:

..Viscosity at 75 F startup..

...0W-20.....0W-30.....0W-40

The numbers are not exact but they show clearly that the "0" represents different startup viscosities. This is unlike the 0W-30, 5W-30, 10W-30 and straight 30 weight oils that all have the exact same viscosity in a hot engine = 10 cS.

I would like to comment on the following statements made by a knowledgeable automotive enthusiast: "Pressure and flow are tied together with viscosity, but none have anything to do with lubrication. Lubrication is a property of the fluid, not the force. The oil pump would pump water just as well, but it would offer no real lubrication. If we double the pressure, we double the flow. If you decrease the viscosity to a lighter oil, you increase flow at a loss of pressure. High flow helps to carry away more heat. High pressure helps to keep metal parts like the bearings out of contact with each other (scuffing)." I give you the following example to help visualize what is happening. This assumes the oil has no internal resistance. In actuality doubling the pressure will not double the flow but will be slightly less. And thicker oils have more resistance than thinner oils for all situations. But simplified we get the following:

For a 30 wt oil at operating temperature: RPM....Pressure..Flow 1,000.....20 PSI....1 2,000.....40 PSI....2 4,000.....80 PSI....4 8,000... 160 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 5

For a 30 wt oil at operating temperature and a higher output oil pump: RPM....Pressure..Flow 1,000.....30 PSI....1.5 2,000.....60 PSI....3 4,000....120 PSI....6 The maximum flow because of the oil pop off valve at 90 PSI will be 5 8,000... 240 PSI....12

If we stick with the same weight oil and increase the oil pump output we will increase the pressure and the oil flow too. If we double the oil pump output we will double the pressure and we will double the oil flow (in an ideal system). RPM....Pressure..Flow 1,000.....40 PSI....2 2,000.....80 PSI....4 4,000....160 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 5 8,000... 320 PSI....16

Let us compare a 40 wt oil at operating temperature: The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow. RPM....Pressure..Flow 1,000.....30 PSI....1 2,000.....60 PSI....2 4,000....120 PSI....4 The maximum flow because of the oil pop off valve at 90 PSI will be 3 8,000....240 PSI....8

For a 40 wt oil at operating temperature and a higher output oil pump: RPM....Pressure..Flow 1,000.....45 PSI....1.5 2,000.....90 PSI....3 The maximum flow because of the oil pop off valve at 90 PSI will be 3 4,000....180 PSI....6 8,000... 360 PSI....12

For a 40 wt oil at operating temperature with the original pressures: RPM....Pressure..Flow 1,000.....20 PSI....0.5 2,000.....40 PSI....1 4,000......80 PSI....2 8,000... 160 PSI....4 The maximum flow because of the oil pop off valve at 90 PSI will be 3

Increasing the pressure while using the same oil will increase the oil flow but increasing the pressure by increasing the oil thickness will result in less flow. It takes more pressure to move a thicker oil. When you go to a thicker oil the pressure goes up because of the increased resistance, and therefore reduction of flow.

There is more to these graphs but I will contiue with the next chapter.

Furthermore pressure does not equal lubrication. Let us look at a single closed "lifetime lubricated" bearing. We could hook up a system to pressurize the bearing. This can actually be done. We could have the oil at ambient pressure. We could then double, triple, quadruple the pressure of the oil. The oil is noncompressible. Regardless of the pressure we would have the exact same lubrication, that of the ambient pressure lubrication.

The physics of lubrication as I said earlier show a 1:1 relationship of flow to separation pressure. Lubrication itself is pressure independent. I will not go into the mathematical equations for this.

Even water can be used as a lubricant. This is partly because of its high surface tension. It is used in many medical devices and other systems that are under or exposed to water. It is just that water rusts metal parts making this unsuitable for automotive engines. It actually has a higher specific heat than oil. It can therefore carry away more heat than oil from bearing surfaces. In this respect water is a better lubricant than oil.

aehaas

#### Motor Oil 201

Chapter 10, The graduate.

I am going to bring up the constant flow pump concept. First, it goes back to the principal that doubling the

pressure of the same weight oil does not exactly double the flow but it is close. Also doubling the RPM for the same reason does not exactly double the flow but again it is close.

This shows the problem best:

(A) For a 30 wt oil at operating temperature:
RPM....Pressure..Flow
1,000.....20 PSI....1
2,000.....40 PSI....2
4,000.....80 PSI....4
8,000... 160 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 5

(B) For a 30 wt oil at operating temperature and a higher output oil pump:
RPM....Pressure..Flow
1,000.....30 PSI....1.5
2,000.....60 PSI....3
4,000....120 PSI....6 The maximum flow because of the oil pop off valve at 90 PSI will be 5
8,000... 240 PSI....12

If we stick with the same weight oil and increase the oil pump output we will increase the pressure and the oil flow too. If we double the oil pump output we will double the pressure and we will double the oil flow.

(C) For a 40 wt oil at operating temperature:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow.
Compare this with (A):
RPM....Pressure..Flow
1,000.....30 PSI....1
2,000.....60 PSI....2
4,000....120 PSI....4 The maximum flow because of the oil pop off valve at 90 PSI will be 3
8,000....240 PSI....8

(D) For a 40 wt oil at operating temperature and a higher output oil pump:
RPM....Pressure..Flow
1,000.....45 PSI....1.5
2,000.....90 PSI....3 The maximum flow because of the oil pop off valve at 90 PSI will be 3
4,000....180 PSI....6
8,000... 360 PSI....12

The situations (A) and (C) are close to real life, assuming no loss in the system. This is what happens when you
change the 30 weight oil to a 40 weight oil in your car:

(A) For a 30 wt oil at operating temperature:
RPM....Pressure..Flow
1,000.....20 PSI....1
2,000.....40 PSI....2
4,000.....80 PSI....4
8,000... 160 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 5

(C) For a 40 wt oil at operating temperature:
The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow.
RPM....Pressure..Flow
1,000.....30 PSI....1
2,000.....60 PSI....2
4,000....120 PSI....4 The maximum flow because of the oil pop off valve at 90 PSI will be 3
8,000....240 PSI....8

At 6,000 RPM the maximum rate of flow has been reached with the thinner oil (A). When you go to 7, 8 or 9,000 RPM you do not get any more flow. You only get a maximum rate of 5. The internal forces on the bearings increase but there is no additional flow of oil.

With the thicker oil you reach maximum flow at 3,000 RPM (C). Worse yet is that the maximum flow is now only 3. As we increase RPM to 4, 5, 6, 7, 8, 9,000 RPM we get no additional pressure and no additional flow, no increase in lubrication.

Next let us look at a 20 weight oil at operating temperature. We get the same flow out of our constant volume pump but the thinner oil requires less pressure to move through the system. This even goes along with the rule that we should use an oil that gives us 10 PSI per 1,000 RPM:

(D) RPM....Pressure..Flow
1,000.....10 PSI....1
2,000.....20 PSI....2
4,000.....40 PSI....4
8,000.....80 PSI....8

The maximum flow rate has not been reached. If the engine went to 9,000 RPM then the flow would be 9 at 90 PSI, our maximum pressure at pop off. The engine now has 3 times the flow rate as with the 40 weight oil at full RPM. The nozzles at the bottom of each cylinder are spraying 3 times the amount of oil lubricating and cooling this section. Everything runs cooler and the separation forces in the bearings are 3 times higher.

For engines that redline at 5,000 RPM they usually pop off the oil pressure at 50 to 60 PSI. For engines that go

to 8-9,000 RPM the pressures max out at 90-100 PSI. You can now see that you can only get the maximum flow rate if you follow the 10 PSI / 1,000 RPM rule.

The winner: 0W-20 weight oil for my Maranello. I said earlier that I could use a 10 weight oil. I actually only run with 185 F oil temperature around town and the pressures are similar to the 40 weight oil example in (C) above. This is why I also said that in the racetrack condition, with hotter, thinner (0W-20) oil I may actually get the optimal results as in (D) above.

Now let us go back to the Ferrari recommended parameters in my 575 Maranello manual. It calls for 75 PSI at 6,000 RPM. The pop off pressure has not been reached. As we now increase the RPM we still get an increase in flow rate. This is what we need and this is exactly what they are recommending. We get our maximum flow at the maximum system pressure, at about the maximum engine RPM of 7,700. There is no bypassing of the oil. All oil pumped goes through the system. There is no wasted BHP pumping oil past the bypass valve back to the oil tank. It is the perfect system.

Finally I will compare a single, 30 weight oil, at normal (212 F) and at racetrack (302 F) temperatures:

(A) For a 30 wt oil at normal (212 F) operating temperature:
RPM....Pressure..Flow
1,000.....20 PSI....1
2,000.....40 PSI....2
4,000.....80 PSI....4
8,000... 160 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 5

(E) For a 30 wt oil at elevated (302 F) operating temperature. The oil is thinner at 302 F. It requires less pressure to get the same flow:
RPM....Pressure..Flow
1,000.....10 PSI....1
2,000.....20 PSI....2
4,000.....40 PSI....4
8,000.....80 PSI....8 The maximum flow because of the oil pop off valve at 90 PSI will be 9

The hotter (302 F) 30 weight oil is thinner than the cooler (212 F) 30 weight oil. It has the same flow rate in the constant volume oil pump but at a lower pressure than the oil at normal operating temperature. This allows for a doubling of the flow rate at peak RPM. The thinning of oil at higher temperatures is a benefit. You get more flow, more cooling and more lubrication.

The 30 weight oil at 302 F has the exact same flow rate and pressures as the 20 weight oil at 212 F. See (D) above. Therefore, use the 20 weight for around town driving and the 30 weight on the hot track. You get maximum flow at each situation.

For YOUR engine, substitute the actual flow at 1,000 RPM. If your engine puts out 1.5 liters/min. at 1,000 RPM it would put out 3 liters/min. at 2,000 RPM and 6 liters/min. at 4,000 RPM and so on. The maximum flow in (A) would be 7.5 liters/min. In situations (D) and (E) you would get a maximum of 13.5 liters/min.

#### Conclusions:

The reason that multigrade oils were developed in the first place was to address the problem of oil thickening after engine shutdown. Over the years we have been able to reduce the amount of thickening that occurs. Never-the-less there is no oil that does not thicken after you turn your engine off. This is why we have to warm up our engines before revving them up. Engine designers always pick the recommended oil based on a hot engine and hot oil. There is no issue with oil thinning as they are both matched when hot. The problem is oil thickening when the engine cools.

Cold engine showing very high pressures because of the thickened oil at startup:

For a 40 wt oil at 75 F at startup: The oil is thicker, has more internal resistance and therefore requires more pressure to get the same flow. RPM....Pressure..Flow 1,000.....60 PSI....1 2,000....120 PSI....2 The maximum flow because of the oil pop off valve at 90 PSI will be 1.5 4,000....240 PSI....4 8,000....480 PSI....8

At 1,500 RPM you reach the maximum oil flow rate and if you run to 8,000 RPM it is the same rate. The flow cannot increase and it is insufficient. This is why we must wait until our oil temperature comes up to 212 F or higher. The maximum flow rate in this case will then double, up to 3. To get even more flow in our test engine you need to use a lower viscosity grade.

If you have absorbed and digested the information here you should be able to pick out the proper operating oil weight for your car, be it a 30, 40, 50 or even 20 weight oil. I have always used oils that were a grade thinner than recommended even though many use a grade thicker than recommended. I showed evidence that the starting grade should always be 0 or 5 (0W-XX or 5W-XX for thicker oils). If you want the best protection and highest output from your motor use a synthetic based oil. The actual brand is not as critical as the viscosity. The rating must be SL or the upcoming SM rating. Change your oil every 3 - 5,000 miles and at least every spring.

Final examination to follow later.

THE END

#### **Motor Oil Midterm Examination**

Answer questions without looking back. This is a closed book exam. Base your answers on the information provided in these past chapters.

1- At normal operating temperature, 212 F, a straight 30 weight oil has a viscosity of how many centiStokes? A- 3

- B- 6
- C- 10
- D- 20
- E- 30

2- While racing at 95 F, mid-summer in Florida, which of these synthetic oils gives the best protection at 302 F oil temperature?

- A- 0W-40
- B- 5W-40
- C- 10W-40
- D- Straight 40 weight
- E- They are all exactly the same

3- While starting up your car at 75 F, mid-winter in Florida, what is the approximate viscosity of a straight 10 (ten) weight motor oil?

- A- 3 cS
- B- 6 cS
- C- 10 cS
- D- 20 cS
- E- 30 cS or higher

4- The biggest problem with mineral based motor oils with long term use is:

- A- Thinning
- **B-**Thickening
- C- Loss of VI (viscosity index) improvers
- D- Both A and C
- E- None of the above is correct

5- Which of the following mineral based motor oils are still too thick at a 75 F startup temperature?

- A-20 weight
- B-10 weight
- C-5 weight
- D- All of the above
- E- None are too thick

#### Answers to the Oil Midterm Exam

I feel these were all difficult questions. You would be doing well to get 3 correct.

1- At normal operating temperature, 212 F, a straight 30 weight oil has a viscosity of how many centiStokes? A- 3

B- 6

C- 10

D- 20

E- 30

The correct answer is C- 10 cS.

2- While racing at 95 F, mid-summer in Florida, which of these synthetic oils gives the best protection at 302 F oil temperature?

A- 0W-40

B- 5W-40

C- 10W-40

D- Straight 40 weight

E- They are all exactly the same

The correct answer is E- They are all exactly the same.

3- While starting up your car at 75 F, mid-winter in Florida, what is the approximate viscosity of a straight 10 (ten) weight motor oil?

- A- 3 cS
- B- 6 cS
- C- 10 cS
- D- 20 cS
- E- 30 cS or higher

The correct answer is E- 30 cS or higher.

4- The biggest problem with mineral based motor oils with long tern use is:

A- Thinning

- B- Thickening
- C- Loss of VI (viscosity index) improvers
- D- Both A and C
- E- None of the above is correct

The correct answer is B- Thickening

5- Which of the following mineral based motor oils are still too thick at a 75 F startup temperature?

- A-20 weight
- B-10 weight
- C-5 weight
- D- All of the above

E- None are too thick The correct answer is D- All of the above

#### **Motor Oil Final Examination**

Answer questions without looking back. This is a closed book exam. Base your answers on the information provided in these past chapters.

1- While starting up your car at 75 F, mid-winter in Florida, which of these synthetic oils provides the least startup resistance, minimal battery and starter motor load?

A- 0W-20

B- 0W-30

C- 0W-40

D- 0W-50

E- They are all exactly the same

2- While vacationing in Orlando, it is 104 F mid-summer in Florida. The rental car company put a straight mineral based 30 weight oil in their car because they wanted the operating temperature viscosity to be at 10 cS. What will be the approximate viscosity of the oil when you start up your engine now? (Closest answer)

A- 10 cS

B- 20 cS

C- 30 cS

D- 100 cS

E- 400 cS

3- While vacationing in Florida you are able to race your car at the Sebring track. At an oil temperature of 302 F what is the approximate difference in viscosity between a 20 and 40 weight oil. (Pick the closest number)

A- 1

B- 10

C- 20 D- 40

E- 400

4- Assume there are no losses in the system and your oil pump is truly volume based. Also assume there is no cut off pressure valve and you are using a 40 weight motor oil. If at 1,000 RPM your pressure is 30 and your pump output is 1 (one), what will the pressure and output be at redline, 8,000 RPM?

A- 240 PSI, flow = 8

B- 180 PSI, flow = 8

C- 240 PSI, flow = 4

D- 180 PSI, flow = 4

E- 120 PSI, flow = 8

5- Water can be used as a lubricant.

A- True

B- False

6- If you increase the pressure in a bearing, all other things being constant, the force of separation between the parts increases.

A- True

B- False

7- The best weight oil for racing any Ferrari or Lamborghini is a 40 weight multigrade synthetic oil like Mobil One 0W-40.

A- True

B- False

8- For my Maranello 575 the 0W-20 weight Mobil 1 oil is actually too thick for my driving conditions.

A- True

B- False

9- The major problem with engine oil is that it thins with increasing temperature.

A- True

B- False

10- Your 1993 sports car manual states to use an API / SAE SH rated 10W-40 mineral based motor oil. Your engine has only 1,550 miles on the odometer. On your next oil change it would be better to use a SM rated 0W-40 synthetic oil.

A- True

B- False

11- According to SAE J300 a 30 weight oil has a viscosity of between 9.3 and 12.4 centiStokes at operating temperature (212 F).

A- True

B- False

12- In my list of recommended oils what did I list as the best mineral based motor oil in the 50 weight class?

A- Pennzoil multigrade 20W-50

B- Castrol GTX 15W-50

C- Red Line 10W-50

D- Valvoline Durablend 0W-50

E- No oil was recommended

13- You are running 5W-40 Shell Helix Ultra fully synthetic motor oil in your Mercedes Benz. You are in a K-

Mart shopping center and checked your oil and it is 1 1/2 quarts low. You will need to add one can of oil. Which of the following is the best choice.

- A- Mobil 1 0W-40
- B- Pennzoil Synthetic 5W-40
- C- Red Line Synthetic 5W-40
- D- Castrol Syntec 0W-30
- E- Shell mineral based 10W-40

14- Motor oils that are labeled "for racing only" should not be used for everyday driving because:

- A- They do not have detergents
- B- They may have harmful levels of some additives
- C- They are generally unrated, there is no SJ, SL or SM approval
- D- You would have to take your engine apart and clean it periodically
- E- All of the above
- 15- ASTM stands for:
- A- Automotive Standards and Test Methods
- B- Automotive Society for Tooling and Machining
- C- American Society for Testing and Materials
- D- American Standards Trade and Manufacturing
- E- Society for American Standard Testing Methods

16- If your engine is running too hot at higher RPM one thing you can try to bring the temperature down is to use a thinner oil.

- A- True
- B- False

17- Oil with a startup thickness of 100 (at 75 F) that becomes the appropriate thickness of 10 when fully warmed up (212 F) is called a 10W-30 weight motor oil.

- A- True
- B- False

18- A main advantage that the synthetic has over the mineral based oil of the same grade is the ability to lubricate better at startup.

- A- True
- B- False

19- In ASTM D 4485 3.1.4: Engine oil is defined as - - "a liquid that reduces friction and wear between moving parts within an engine, and also serves as a coolant."

- A- True
- B- False

20-I am (single best answer):

A- Surgeon

- **B-**Biochemist
- C- 'Halfass mechanic
- D- Absurdly interested in motor oils
- E- All of the above

#### Answers below:

#### Answers to the Oil Final Exam

I feel these were all very difficult questions. You would be doing well to get 10 correct.

1- While starting up your car at 75 F, mid-winter in Florida, which of these synthetic oils provides the least startup resistance, minimal battery and starter motor load?

A- 0W-20

B- 0W-30

C- 0W-40

D- 0W-50

E- They are all exactly the same

The correct answer is A- 0W-20.

2- While vacationing in Orlando, it is 104 F mid-summer in Florida. The rental car company put a straight mineral based 30 weight oil in their car because they wanted the operating temperature viscosity to be at 10 cS. What will be the approximate viscosity of the oil when you start up your engine now?

A- 10 cS

B- 20 cS

C- 30 cS

D- 100 cS

E- 400 cS

The correct answer is D- 100 cS

3- While vacationing in Florida you are able to race your car at the Sebring track. At an oil temperature of 302 F what is the approximate difference in viscosity between a 20 and 40 weight oil. Pick the closest number.

A- 1

B- 10

C- 20

D- 40

E- 400

The correct answer is A-1

4- Assume there are no losses in the system and your oil pump is truly volume based. Also assume there is no

cut off pressure valve and you are using a 40 weight motor oil. If at 1,000 RPM your pressure is 30 and your pump output is 1 (one), what will the pressure and output be at redline, 8,000 RPM? A- 240 PSI, flow = 8 B- 180 PSI, flow = 8 C- 240 PSI, flow = 4 D- 180 PSI, flow = 4 E- 120 PSI, flow = 8 The correct answer is A- 240 PSI, flow = 8

5- Water can be used as a lubricant.A- TrueB- FalseThe correct answer is A- True

6- If you increase the pressure in a bearing, all other things being constant, the force of separation between the parts increases.

A- True B- False

The correct answer is B- False

7- The best weight oil for racing any Ferrari or Lamborghini is a 40 weight multigrade synthetic oil like Mobil One 0W-40.

A- True

B- False

The correct answer is B- False. It can best be determined by driving the car with one type of oil and see what happens.

8- For my Maranello 575 the 0W-20 weight Mobil 1 oil is actually too thick for my driving conditions.

A- True

B- False

The correct answer is A- True

9- The major problem with engine oil is that it thins with increasing temperature.

A- True

B- False

The correct answer is B- False. The problem is thickening when the engine is turned off. With long term use the problem is also thickening.

10- Your 1993 sports car manual states to use an API / SAE SH rated 10W-40 mineral based motor oil. Your engine has only 4,550 miles on the odometer. On your next oil change it would be better to use a SM rated 0W-40 synthetic oil.

A- True B- False The correct answer is A- True

11- According to SAE J300 a 0W-30 and a straight 30 weight oil must have a viscosity of between 9.3 and 12.4 centiStokes at operating temperature (212 F).

A- True

B- False

The correct answer is A- True

12- In my list of recommended oils what did I list as the best mineral based motor oil in the 50 weight class? A- Pennzoil multigrade 20W-50

B- Castrol GTX 20W-50

C- Red Line 15W-50

D- Valvoline Durablend 20W-50

E- No oil was recommended

The correct answer is E- No oil was recommended. They all are too thick at startup for daily use.

13- You are running 5W-40 Shell Helix Ultra fully synthetic motor oil in your Mercedes Benz. You are in a K-Mart shopping center and checked your oil and it is 1 1/2 quarts low. You will need to add one can of oil now. Which of the following is the best choice.

A- Mobil 1 - 0W-40

B- Pennzoil Synthetic 5W-40

C- Red Line Synthetic 5W-40

D- Castrol Syntec 0W-30

E- Shell mineral based 10W-40

The correct answer is E- Shell mineral based 10W-40. You can mix any SM rated oil in there but this is my first choice based on my research.

14- Motor oils that are labeled "for racing only" should not be used for everyday driving because:

A- They do not have detergents

B- They may have harmful levels of some additives

C- They are generally unrated, there is no SJ, SL or SM approval

D- You would have to take your engine apart and clean it periodically

E- All of the above

The correct answer is E- All of the above

15- ASTM stands for:

A- Automotive Standards and Test Methods

B- Automotive Society for Tooling and Machining

C- American Society for Testing and Materials

D- American Standards Trade and Manufacturing E- Society for American Standard Testing Methods The correct answer is C- American Society for Testing and Materials

16- If your engine is running too hot at higher RPM one thing you can try to bring the temperature down is to use a thinner oil.

A- True B- False The correct answer is A- True

17- Oil with a startup thickness of 100 (at 75 F) that becomes the appropriate thickness of 10 when fully warmed up (212 F) is called a 10W-30 weight motor oil.

A- True

B- False

The correct answer is A- True

18- A main advantage that the synthetic has over the mineral based oil of the same grade is the ability to lubricate better at startup.

A- True B- False

The correct answer is A- True

19- In ASTM D 4485 3.1.4: Engine oil is defined as - - "a liquid that reduces friction and wear between moving parts within an engine, and also serves as a coolant."

A- True B- False The correct answer is A- True

20- I am (single best answer):
A- Surgeon
B- Biochemist
C- 'Halfass mechanic
D- Absurdly interested in motor oils
E- All of the above
The correct answer is E- All of the above

## 328/308 Coolant Thermostat Replacement Procedure

## Author : Unknown

I just did this about a month ago on my 308QV, which uses the same thermostat as your 328. It's one of the simpler do-it-yourself tasks, and I did it twice, since I first used a "compatible" thermostat from a VW Rabbit, but when I still had cooling problems I went with a proper Ferrari thermostat

Put the car on level ground. Remove lower hose from coolant overflow tank in engine bay, drain to a shallow bucket or oil catcher pan. Remember that animals find the smell/taste of coolant pleasant, but it's poisonous.

Remove big connecting air hose from lid of airflow box, then remove lid of airflow box and remove air filter. Stuff a rag over the hole(s) in the bottom of the box.

Remove the three nuts that hold the top of the thermostat housing cover to the block and remove the top of the thermostat housing. You may or may not have to remove the exit hose from the thermostat housing to be able to wiggle it off, exposing the thermostat.

Remove and replace the thermostat and circular rubber gasket that is around the outer edge. If your thermostat is the proper heavy duty one from Ferrari or Ferrari suppliers (rather than using an "almost the same" from Autozone), it will have a small relief hole in the flat disk portion. Rotate the thermostat so the hole is positioned on the highest edge. This is so that any air doesn't get "caught" there.

Replace the thermostat housing triangular paper gasket with a new one. If you choose to, you can put a VERY TINY line of silicone sealant on it (optional).

Reassemble, refill coolant overflow tank to proper level. Open bleed valve on thermostat housing until coolant just starts to come out, then retighten.

It probably took me 45 minutes to an hour total the first time, and maybe 20-30 minutes the second time I did it a day or two later with the other thermostat.

Recheck level in overflow tank, and do the "usual" air bleed procedure after warming your engine and checking for leaks. You will find that you probably did NOT leave much, if any, air in your system by doing it this way, so there will be very little to bleed off (unless you already had air in the system before the procedure).

## **Coolant and Radiator Fill and Bleeding**

## **Author : Verell**

You can refill it w/o running the engine.

1)BEFORE REFILLING/TOPPING OFF THE SYSTEM: Set the vent temp. levers to HOT, open the radiator bleed valve & put a little container under it to chatch coolant. This ensures you bleed the two heater cores out thru the radiator as you fill the system. If you don't do this, you'll have a couple of quarts of air in the system.

If the system is pretty full, let it bleed until the air & foam are gone & only coolant is coming out, then close the valve until step 3.

Remove the bleed screw on top of the thermostat housing (Early carb'd cars don't have one).

If you have a bleed screw, consider drilling it so it doesn't have to be completely removed to blead the thermostat housing. Drill a 3/32" hole into the side of the screw. Top of hole should be about 4 threads down from the head. Then drill an axial hold up the center of the screw until it intersects the 1st hole. Otherwise you're constantly rushing to get the screw started back into the thermostat housing while it's busy peeing coolant.

2) Remove the coolant tank cap,2a.check tank level & fill if below spec

3) Bleed the radiator until no foam, only coolant flows.3a.Check coolant tank level & fill if below spec4) Bleed the thermostat until no foam, only coolant flows.

4a.check coolant tank level & fill if below spec

6. Repeat 3 & 4 until only coolant comes out of the bleed valves.

7. Start up the engine, let it run until warm.

(NOTE: The coolant tank cap is still OFF so the system won't pressurise.

- 8. Repeat steps 3-6.
- 9. Replace coolant tank cap.
- 10. Drive it until good & hot (should NOT overheat) while still keeping the temp levers on HOT.
- 11. Let it cool down & repeat steps 3-6.
- 12. Adj the temp levers to suit yourself.

## **3X8 Fuel Line Replacement**

## Author: PT328

1. Drive as much fuel as possible out of the car. When the reserve light comes on you have approximately 4 gallons left in the tanks.

2. Extinguish all pilot lights (water heater ), and I unplugged all appliances for safety. Fuel vapors/fumes will tend to stay 18" or lower but an unexpected wind might change that. Safety first.

3. Drive car up on 2X10's to allow jack clearance under car. Not necessary if you own a low jack. Place wheel chocks and apply parking brake. Remove negative terminal connection from battery.

4. Loosen driver's and passenger side wheel lugs. Can be done independently.

5. Lift car and place jack stands in appropriate locations. You cannot be too safe in doing this. I did one side at a time

6. Remove driver's and passenger side wheel and wheel well liner. Some minor manipulation of the wheel well liner is necessary for removal. I placed all corresponding nuts, bolts and screws in marked baggies as not to lose them. I also took pictures to refer to if needed.

7. Drain remaining fuel by using one of these methods:

A. Remove hose from the accumulator to the fuel pump at the fuel pump. Bend hose downward and place inside a pipe/hose. Place the other end of the hose in a 5 gallon container. Remove blue connector left of the distributor by removing the metal retainer clip. This will allow the fuel pump to operate with the key in the 1 position.

B. Place a large container under the fuel drain plug located in the crossover pipe. Remove drain plug (22mm) and allow fuel to drain into container. The fuel will drain much faster than oil, so be prepared. I kept the drain plug in my hand in case my estimate for remaining fuel was incorrect.

8. Now the fun begins, I purchased my hoses from Napa. I used the Goodyear

Weatherhead 450 PSI rated fuel line in sizes 5/8 ", 1/4" , 5/16" and Napa part number 1055 for the fuel filler neck. You will need a Cavis (clear hose) running from the fuel filler neck to the breather crossover pipe. Purchase through a Ferrari parts supplier. It is also best to purchase the proper fuel hoses connecting the fuel crossover pipe to the bottom of the fuel tanks. This hose is difficult to find and due to the sensitive nature of

the location and holding fuel, it is strongly recommended that the proper hose is used. There is no need to skimp and save here. Norma smooth clamps were purchased from McMaster Carr for all applications.

9. Many of theses hoses are difficult to reach and removing the hoses can be induce the use of words you may not have used for some time. I found it easier to remove the air filter assembly, and some equipment found near the drivers side firewall to gain easier access to the hoses at the top of the tanks. I had to cut off the majority of the hoses in order to remove them. DO NOT force them off the lines as you may break a fuel tank nipple. I started by removing the hoses closest to the rear of the car IE fuel filler neck, charcoal canister and moved toward the front of the car marking each one with the applicable parts diagram reference number. To replace I did the reverse by starting with the hoses located near the firewall and moving toward the rear of the car.

I found it easier to remove the metal crossover pipe near the firewall to replace the 2 short 5/8" hoses that connect between the top of the 2 fuel tanks. Be careful as to not drop the rubber clips that hold this metal hose as it may take time to find. I also found it easier to place a small amount of Vaseline in the hoses prior to installing them.

10. After you have triple checked the hoses and clamps and replaced any removed parts fill the tanks with about 3 gallons of gas, prime the fuel pump and check for any leaks. I left the wheel well liners off while checking for leaks and replaced them when my safety check was complete. If all is good fire it up ( outside ) and double check. Replace wheel well liners and if all is well go for a drive and enjoy your accomplishment.

I did my fuel line replacement over about a 6 week period with a total of about 25 to 30 hours. I was not in a hurry and worked on it in short bursts since my wife had me too busy with other things.

#### PARTS LIST

150 inches of 5/16" mostly for the vent/vapor lines.

40 inches of 5/8" for applications at the fuel pump as well as some vent/vapor lines.

30 inches of 1/4" for the drain tube that runs along the driver's tank from the fuel filler.

8 inches of 1 ½" for the two crossover lines between the 2 fuel tanks. I attempted to use the 1 3/8" but it was impossible to get on. I spoke with my independent mechanic who said he uses the yellow stripe Napa 1 ½" for this application and has not had a problem. I used double clamps to make sure there were no leaks. (Recommended: Use Ferrari hose for this critical connection.) 4 inches of 2 ¼" for the fuel filler neck Napa part # 1055.

Norma clamps from McMaster Carr in multiple sizes. A few zip ties to button up the hoses, a good utility knife, flashlight, and plenty of tools, and most importantly Band-Aids. The Norma clamps use a 7mm fitting to tighten for most applications.

I have posted some before and after pics of this process. I got so excited that I was done I forgot to snap more pics before I got the wheel well liners back on. Good luck to those embarking on this endeavor. I hope this is helpful.

Attached Images



## **Changing the Ferrari 328 Fuel Filter**

Carl Rose February 2003

This is really not a difficult job, just requires a bit of contortion; plan on about 2 hours the first time. I did this on my garage floor, but if you have access a lift might prove ideal. Factory recommends replacing filter at 30k/52.5k/75k mile services. *(example shown is 1988.5 car, but the entire series is identical)* 

#### Parts required:

Bosch fuel filter #0450905601-85E (box labeled #71039) from BAP-Geon \$16 Copper fitting washers NAPA #1242 & #1243 (not included with my filter) approx \$1.20

### Tools required:

Floor jack/frame stand Lug nut wrench (I use Snap-On 7/8" with aluminum insert & zip-lock plastic bag to prevent marring lug bolts) 16mm & 17mm flare nut wrenches 17mm & 19mm combination wrenches (reversible ratcheting 17mm combination wrench would have made removing firewall bracket much easier) Large adjustable wrench Metric 6-pt 3/8-drive socket set Catch pan (I used small kitty-litter pan)

Disconnecting the battery is always advisable (can simply disconnect ground strap at left front). My fuel injection manual recommends disconnecting battery then (with ignition off) jumping 12v (+) to cold-start injector for 10 seconds to relieve K-Jetronic system pressure. Can't comment on this; instead I avoided running the car for a week beforehand and had no problems. Goes without saying to work in well-ventilated area unexposed to open flames, etc.

#### **Procedure in Detail:**

Block the front wheels. Break the torque on the left rear wheel lug nuts (I lifted only the left rear wheel, but you could lift the entire rear section if desired)

My floor jack would only fit under the car diagonally from the left rear corner; positioned on suspension-mount frame section. I used a thin piece of wood and OR towel to protect the frame. My jack stands were too tall to position under the frame rail once lifted, so I improvised a stand out of 4x4 wooden blocks securely fastened together. Blue masking tape is index of wheel location on rotor.

Depressurize fuel system, disconnect battery, well-vent area, no open flames, etc. Remove the lug bolts and wheel. Inner wheel well shield removal is not necessary. The left fuel tank and fuel pump are readily visible; trace the braided outflow fuel line to the fuel filter mounted on the firewall bulkhead. While in the vicinity inspect the tank-to pump and crossover rubber fuel lines. Both factory fittings on my car had yellow paint daub markings. Using the 16mm flare wrench (*note: this is not a standard size*) loosen the upper metal fuel line coupling from the adaptor fitting (which will be removed on bench). I was able to hold the adaptor at the lower fitting with a 19mm wrench; despite cleaning off undercoating I was unable to fit my 17mm flare wrench over the lower braided coupling and eventually was successful using an 11/64 flare wrench (17.4mm). After loosening these lines I had a reasonably steady flow of gasoline as the fuel filter drained. Unfortunately this acts as a solvent on the undercoating making a bit of a mess.

Most challenging part of the entire procedure is removing the 17mm hex nyloc filter bracket retaining nut. Due to the curvature of the bracket, it cannot be directly assessed

with a standard socket. A crows-foot with extension might work, but I was able (with patience) to loosen using a 17mm open-end wrench pivoting parallel to the aluminum firewall sheeting. Be prepared to catch the nut and washer – the encircling bracket is quite springy! Fuel filter is then easily removed from car. After filter is removed firewall appears such:

Each end of the fuel filter has a different brass adaptor fitting which is re-used. Holding the nut molded into the filter with large adjustable wrench, I removed each with a 6-pt



socket (16mm & 15mm as I recall) to prevent marring flats. Two small (also differently sized) copper washers function as in-line gaskets; NAPA sells slightly thinner (perfectly

functional) washers as parts #1242 and #1243 for about 60¢ each [the Wix replacement for this Bosch filter comes with two sets of gaskets that were identical to factory that I was able to persuade the parts counter gentleman to sell for \$2]. Transfer the adaptor fittings onto respective ends of the new filter; I am unaware of a specific torque value but went to "tight" back-holding molded hex on filter. Arrow on filter indicates direction of fuel flow (from under car, arrow should point directly upward). Notice the slight difference in shoulder configuration between the original (with undercoating) and current Bosch issue:



New filter with adaptors installed:

I placed a piece of masking tape at the approximate location the bracket should be located on the new filter (using the previous as a reference). I tried several techniques but was most successful loosely installing the bracket on the firewall stud with hex nut and



washer then maneuvering the new filter down into the bracket from above. Tighten the bracket slightly but leave the filter mobile at this point.

Center the outlet fuel line over the adaptor and hand-tighten the coupler fitting. I ran it down, then partially loosened, then re-tightened to ensure the line was centered. Similarly affix the lower input braided line. There is a small bracket for the gas tank strap near the

filter – I made sure the lower aspect of the filter was not against this (to prevent vibration-induced abrasion/rupture of filter) and tightened the bracket nut. Tighten the

fuel line couplers; again use a 19mm to hold the lower adaptor fitting while tightening the lower coupler and use 16mm flare on the upper. Fuel filter reinstalled in place on firewall (view upwards):

As access to the filter is difficult once the car is returned to the ground, I chose to run the



car *in situ* to test for leaks. Gearshift in neutral, standing beside car started up; sputtered a bit and the fuel pump made some noise until the system re-pressurized (about 15sec). Shut car off and inspected fittings- fortunately no leaks. Reinstalled wheel and lightly

tightened lug bolts. Jack car & remove frame stand. Torque wheel bolts to 72ft-lbs apiece, going around bolt circle twice.

Congratulations. Suspect this is a \$125 job at the dealer.

## Filler neck hose replacement

## **Author : Steve King**

After removing the wheel and then the inner fender liner, you need to remove the air duct for the oil cooler. If you loosen both clamps on the cooler duck and remove the bolt near the dizzy coils, you can move the duct enough to take it out of the fender well. Next, remove the filler neck hose clamps. Slit the hose to take it off. The replacement hose was from NAPA and it is 2 1/8" ID hose. Next is cut the hose to the same length as the OEM hose. This is important or you will struggle to put it on if you make it to long. Next, pulled the filler neck down and toward the side of the car, removed it. Slid on the new fuel hose and moved it down as far as possible on the gas tank neck. Use your finger and put some oil around the big rubber grommet where the filler neck goes. Push the neck up through the grommet and at the same time push on the rubber hose to collapse it. Push the filler neck up as far as possible and it should just clear the rubber hose. Line up the neck with the hose and from the top push the neck down. Now take the big hose and move it around until it is centered between both the fill and the gas tank. Unscrew the band clamps, put them around the hose, and tighten. Replace the two other hoses with the right size hoses and you are ready to put back the liner and wheel. You can do this on the floor or on a lift. I have a lift so I am sitting down when I do this.

## 328 (1987) Front Bearing

## Authors: Ernie (minor additions by JohnnyS)

Inspecting the front wheel bearings on a 328 is rather easy and the bearing are similar to the 348 bearings. Here is a basic procedure:

- 1. Block the rear wheels and make sure the parking brake is on. Raise the car and place jack stand(s) in appropriate points to hold the front wheels off the ground.
- 2. Remove the wheel to expose the brake caliber and rotor.

3. Remove the two bolts holding the brake caliper bracket in place and carefully swing out of the way.

Use a strong wire (clothes hanger type) to hold up the caliper so as to not place stress on the brake hose.

- 4. Remove the two studded screws from the rotor and remove the rotor. These hold the rotor on the hub.
- 5. Remove the six (6) bearing retaining bolts from the back of the hub

Picture of the 348 Bearing (with ABS) (Right):



Actual bearing :



Axel Diagram For 328 with Partial Part Number Table:



Ref	Part	Qty	Description
1	125672	2	Front wheel hub
2	124464	2	Stay bolt for bearing
4	13909870	2	Pin
5	124642	2	Nut
6	112799	2	Bearing
7	14238731	12	Screw
8	118522	2	Washer
9	117171	2	Bearing cover
10	113040	2	Suspension spring GTS U.S. version
10	110784	2	Suspension spring GTB
10	112876	2	Suspension spring GTS
10	113516	2	Suspension spring GTB U.S. version
11	105223	2	Upper spacer
12	103264	2	Lower spacer
13	128177	2	Shock absorber
14	104414	2	Pad No spare
15	100809	4	Estendblock

Now that the bearing and hub are out, remove the "Stay Bolt" (#2 in diagram) You will be unpeening the 30mm ring nut and then removing it with an impact wrench/gun (Normal threads).

After you have the nut removed you will need to remove the bearing from the flange. (Install torque for the Stay Bolt is 57 ftLbs for a 1987 328 per an auto repair shop.)



Sorry boys but this step I have absolutely zero pictures of.

The easiest thing to do is press out the bearing, but seeing as I didn't have a press I, Stooged it. What I did was place a large socket inside the inner bearing race. Then I turn the bearing and race upside down with the socket on the bottom now. Then holding the outer bearing race I began to bang the race down against the socket. Little by little the race slide off the shaft on the flange due to the small impacts of the socket hitting the ground. Yes I know the was waaaaaaay caveman, but it worked. Okay I ran out to the garage and mocked up what I was just describing.

A 36mm socket fits inside perfect.

Then turn that sucker upside down and smack it out(Photo to the right and below.)



Hear is what the bearing looks like all torn apart.

1st Pic is of the outer bearings.2nd Pic is of the inner bearings3rd Pic bearings sitting in the cage4th Pic inner bearing race











Now came the son-of-@#!!@ part.

Once you have the outer race and first inner race off you have to take off the race that sits flush against the flange. I don't have a picture of what it looks like, but I took one with the race sitting flush with an insert sticking out give you an idea of what it looks like. The white insert would be the shaft of the flange sticking out.

See the problem is that since the race is tapered you cannot grab it with a puller. There isn't a sharp edge for the puller to get a sold hold off, and thus just slips off. You also can't get behind it because it is pressed flush on the back of the flange.



So what do you do know?

Well what I figured out was that the outer race and first inner race came off because the bearings where still inside.

Ah HA!!!

See, the bearings were sitting inside putting pressure on the inner race forcing it off. So what we do is put the bearings back on, but BACKWARDS!

Since the outer race is large that the part that the



inner race is sitting on, you can put the outer race on and it will sit behind the inner race like so.

Now you will put the balls bearing back in between the 2 races, then fit the bearing cage back on to hold the balls in place, and have them separated evenly.



NOW ...... you have the sharp edge for your puller to grab.

The ball bearings are being held to the inner race from the back via the pressure place on them from the outer race. Now the race can get pressed off of the flange shaft. (Right)



Well not in my case.

Why? Because Ernie does not own a press. Nor did I had a bearing separator. See you need to have even pressure all around the outer race to get the inner race to press out. A bearing separator looks like two half moons that slide under the baring and then get bolted together to hold them in place. Well I went out to buy one but the "large" separator they had wasn't wide enough for the bolts to slide past the outer race. So I couldn't bolt it together. I found a REALLY big bearing separator but they wanted \$140 for the thing. Sorry but, "Earnie don't pay dat".

So.....

I went to by buddies dad's shop and he took it off with the HOT wrench. Ask how much I owed him, and he said "Just bring me a 6-pack of Bud Light". That's my kind of price! It's good to have friends.



The wheel bearing that came off of my (Ernie's) car was an SKF bearing.

SKF part number: 441696M (Left)

The bearings I ordered were SNR bearings, and the bearings I found out came on the Citroen.

SNR part number: TGB10894S03 (Right)



With all the charges I had to pay each bearing ended up costing me about \$400. I had a look at what the bearings would have cost me getting them from a bearing supply shop and the cheapest price I found was \$246.

This style bearing is used on the following Ferrari models:

F40 ABS equipped 328 (1988..) Non-ABS equipped 328 (? To 1987) Mondial 8, QV, 3.2, t '89-'92 348's Testarossa '87 & '89

## 308/328 Bushings: The Easy Way

## Author : Birdman

Many of you may remember that last winter Verell and I went through the rear suspension of my 308 and did the bushings, powder coated the A arms, etc. and wrote it all up here. That was an example of "doing it right" and taking lots of time to make the suspension better than new.

Well, what I'm about to demonstrate is the opposite. This is what I call the "Get it done, spring is coming" technique.

The problem with these suspension bushings is that they are welded into the A arms and to replace them requires grinding out the welds, pressing out the old bushings, pressing in the new ones, and tack welding them. (Much discussion went into this in the past, and YES you HAVE to weld them).

Someone asked at the end of that previous thread if it would be possible to retrofit new "guts" into an old bushing, thereby eliminating the grinding and welding. The answer is YES! Please observe!

(FYI, this is an A arm from an '83 Mondial. It has the same inner A arm bushings as a 308 and that's what I'm demonstrating...a rear, inner, bushing guts replacement.)

Image 1 is the dead bushing that caused the need for me to do this job. If your bushings look like this (YIKES!), it's time for new bushings, man!! Attached Images

OK, you will notice that the OEM bushing has an outer shell which is pressed into the A arm, and an inner "tube" which is flanged out like a trumpet on both ends to hold it in, with rubber

in between. To get the guts out, you need to cut the flange off one end. It's easiest to cut off the

inner flange so you can press the rest out. I used a sawzall rather than an air grinder because the rubber fouls the grinding disk.

First pic shows the cutting process and second is the result.

Attached Images

BTW, on that last step, be careful to keep the saw away from the A arm. Just cut the bushing! A Sawzall with a new metal blade goes right through the bushing in about 20 seconds, so this is easy.

Now you can press out the guts. If you select the right size pressing impliment (i.e. socket size!) you can press the inner metal tube and rubber all out at the same time. I honestly have no idea



onds, so this is easy.

if you can do this step without a press. That rubber is REALLY stuck in there, because it's bonded somehow to the inside of the outer bushing.

For those of you who roll your eyes and say "Oh, well sure, that guy has a press. I don't have tools like that." I ordered this press from Harbor Freight on sale for \$79 plus \$9 shipping and another \$17.95 for the arbor plates. Yes, a tiny bit over \$100 delivered to my door by UPS. It's a cheapo Chinese 12 ton press that will do 90% of the things the average home car nut will need for cheap money. Works great!



BTW, in the pictures, I'm not actually pressing. When you press, you need to sit the bottom of the A arm with the bushing into a metal tube of some sort to support it all the way around the bushing so you don't bend the A arm. This was just for pics. (I couldn't hold the entire thing and the camera by myself!) I went down to the hardware store and bought a bunch of different sized iron pipe fittings to use as press accoutrements, but some people who have a large selection of monster-sized sockets just use those.



OK, so here's what you get...the OEM outer bushing (still welded into the A arm) is now "gutless". The rubber actually comes out fairly cleanly. I expected to be using a wire brush on the inside and scraping all the rubber pieces out, but there was very little clean up. Once the rubber is broken free by the press, it comes out pretty cleanly.

Next pic shows the mangled guts that come out and you can see the inner "tube" that I cut off with the sawzall.



Now we get out a nice Energy Suspension ("ES") bushing. These are made of polyurethane rather than rubber and people have debated if these are better or worse than OEM. What I can tell you is this...if you want to do this type of "cheater" bushing replacement, you must use the ES bushing because you can't transplant the guts of an OEM bushing. The ES model number is 13-3101 G (30 mm diameter) and you can get it from <u>http://www.suspension.com/ferrari.htm</u> (Suspension Restoration company) and they are currently \$21 a bushing. (Yes, they went up since last year).

The bushing comes as two pieces that snap together. However, the guts of this bushing is only lightly pressed into the outer shell, and comes right out. (See second pic).

The shell is almost the exact same size in all dimensions as the OEM shell. Attached Images



The ES bushings each come with a little packet of super tacky lube. Spread some lube on the polyurethane guts, and spread some inside the outer shell of the bushing on the A-arm, and then stuff the guts into the shell. You will find that it's tight, but not so tight that you can't "press" it together with just arm power as long as it has been lubed with the goop. In fact, the tightness is exactly the same as the tightness of the guts in the original ES shell. They're the same inner diameter.

Tip: The guts are pushed in from the inside of the A arm, not the outside. (Just assemble it the

way it would be assembled if you hadn't recycled the outer shell and the direction is obvious).

Next, pop the other end of the bushing on, and you're done.

You can do each A arm in about 30 minutes or less. It actually takes longer to get the A arm off the car than to do the bushings!

Happy Suspension rebuilding

Birdman Attached Images



The polyurethane bushing is Energy Suspension p/n: 13.3101-G Qty 16 (2 for each of the 2 A-arms at each of the 4 corners) for 308GTB up thru 328s up to S/N 76626.

#### **Bushings : The Normal Way**

This involves replacing the bushings and welding them to the A-arms. This should be performed by a professional welder. Tack welding should be enough and if done quickly, will not damage the rubber.

## 328 Column Switch Replacement Author : JohnnyS

#### **Tools Needed:**

Steering wheel nut socket (Special Tool) Steering wheel hub puller (Two bolt type) Phillips screwdriver Flathead screwdriver Electrical Tape

#### Switch Removal:

- 1. Disconnect the battery
- 2. Remove the horn button. Pull out it is just a friction fit in the steering wheel and has one wire connected to it.
- 3. Remove the steering wheel nut. Have someone hold the steering wheel while applying counter clockwise torque. Be careful of the windshield.
- 4. Using the steering wheel hub puller, pull the hub. It will pop loose.
- 5. Remove the hub while feeding the horn wire through the access hole.
- 6. Remove the key on the column so the switch can slide off the column.
- 7. Remove the lower dash cover. There are three Phillips head screws holding it on. There is the service light power port attached. There is no need to disconnect this.
- 8. Remove the left side coin "pocket" that sits on the left side of the dash. This will expose the wiring plugs for the column switch.
- 9. Remove the two flathead screws holding the column switch.
- 10. Disconnect the three (2 white, 1 red) wiring harness plugs.
- 11. To feed the wire bundles through the small opening at the bottom of the column cover, the wire plugs will need to be removed. If the switch is not going to be fixed, just cut the wires and save the plugs so the new wiring harness can be wired to correctly match the existing wiring.
- 12. Pull switch out while feeding the wire bundles through the small hole.

#### Switch Installation:

- 1. Feed new switch wire bundles through the column cover. Screw in place with flathead screwdriver.
- 2. Attach the wiring plugs in the same manner as the old plugs.
- 3. Attach the plugs and check lights by connecting the battery and testing the new switch. If working improperly, check your wire connections. If okay, disconnect the battery before proceeding. Tape up the wire bundles to hold them together.
- 4. Replace steering column key and place steering wheel and hub on the column. Be sure to feed the horn power wire through the access hold.
- 5. Attach the steering wheel nut and tighten.
- 6. Attach horn
- 7. Attach dash covers.
- 8. Connect the battery and test again. If okay, take a drive. You earned it!

## Ferrari 328 A/C System Inspection, Leak Detection, Compressor Seal Replacement, & Recharge

Carl Rose November 2003/revised June 2004

The 328 uses a conventional expansion valve (non-accumulator) air conditioning system originally equipped with R-12 (Freon) refrigerant. Circuit consists of:

Compressor with magnetic clutch (discharge) line to condenser, Condenser, Line to filterdryer, filter-dryer with low-pressure switch, line to expansion valve, expansion valve, evaporator core (with blower motor & ducting), return (suction) line to compressor

[Electrical aspects of the system comprise: thermostat & blower motor switches, relays, & resistor, magnetic clutch engagement power lead, condenser cooling fan, and low-pressure compressor shut-off circuit]

Compressor is located near firewall on top of passenger side of engine (York 206 for US version, Sankyo 507 for non-US), suction/discharge lines run along right sill, condenser & dryer are just ahead of right front wheel (visible opening hood), expansion valve is covered with gooey black insulation adjacent to brake master cylinder under fiberglass cowl cover, and evaporator core/blower is buried in underdash ducting. Condenser has small dedicated cooling fan. A low-pressure switch on the filter-dryer disengages the compressor clutch when system pressures fall below a preset point.

My 1988.5's A/C system began blowing warm air about 11 months after R-12 recharge during 30K service, prompting this article. Entire 328 series is identical, 308s are slightly different but principles similar.

A few thoughts:

- This job is involved & requires patience, but even purchasing all the specialized tools will be significantly less expensive than having work performed by dealer or A/C shop. And said tools can be used on other vehicles.
- Always a good idea to replace the filter-dryer once the system is opened, especially if >10 years old (desiccant material has been known to break down & circulate, clogging the expansion valve).
- If you can isolate the compressor as faulty component options are repair (economical but unknown duration) or replacement (with new or

remanufactured). Replacing the compressor front shaft seal is certainly economical but given difficulty of access had I known a perfectly matching compressor was available would have simply replaced.

- Replacing the Schrader valves is also a good idea; do not have exact NAPA cross-reference but suspect they are #209578 (standard) or #409914 (metric with neoprene seal for R-134a).
- If you are looking for parts at NAPA look in both the passenger car & "Farm and truck" A/C parts catalogs. Expect the expansion valve is also a standard version.
- Replacement of the A/C belt requires removal of compressor lower bracket and "dropping down" of compressor unit; technically this is functionally similar to complete removal of compressor thus unless belt recently replaced this is a very opportune time.

Authorities vary on recommendations regarding continuing to use R-12 versus converting to R-134a/HCFC blends, proper oil evacuation/flushing of system during conversions, etc. This article will not address these issues – refer to excellent Internet resource site www.aircondition.com (current as of 11/2003). I chose DuraCool HCFC blend as it is available without a license, is relatively inexpensive (\$5/can), does not require flushing of R-12 systems (uses mineral oil), and as I wasn't certain my system was perfectly sealed did not want to spend a fortune on R-12 only to have subsequently leak out. Major drawbacks include: 1. illegal for sale in 18 states, 2. potential flammability as partially composed of propane, and 3. most refrigerant parts warranties specifically prohibit use of HCFC blends. A/C shops may also refuse to discharge system into recyclers. Reference website is www.duracool.com. I understand a license to purchase R-12 in bulk can be obtained online for about \$20 (www.epatest.com).

## Time required:

Compressor removal - 2-3 hours

Clutch removal and front shaft seal replacement – 30 minutes. [with discharge, leak testing, and recharge – plan for an entire day]

## Special Tools required:

- A/C gauge set with 3 hoses (specific to R-12 or R-134a, depending on refrigerant currently in car; Mastercool, Robinair, Snap-On are quality brands)
- A/C vacuum pump (purchased mine a few years ago at pawn shop for \$100)
- Refrigerant (as above) with can tap to install. DuraCool runs about \$5/can, R-134a \$4.50/can, R-12 last I checked was about \$30/can (with license)
- Fluorescent dye A/C leak kit (Mastercool #53585 illustrated) \$70. Small LED light on flexible stalk worked very well for inspecting tight engine bay

- 17mm combination wrench with reversible ratcheting end (I had to purchase separately from Sears for about \$20 - not currently offered in any sets, but well worth it)
- Compressor clutch puller also would be useful; can typically borrow (with deposit) from local Autozone store.
- Krikit (Gates 150) belt tension gauge [Gates part #91107/7401-0071] \$10 at Carquest.

Mastercool UV dye kit:

Gates Krikit belt tension gauge:





## Standard Tools:

- 1/4" & 3/8" metric short & deep sockets 10, 13, 14, 17mm, 7/8" with short/long extension bars & universal joint
- Large combination wrench or good adjustable wrench for compressor fittings
- Philips screwdriver
- Torque wrench
- Telescoping magnetic pickup (for items dropped into inaccessible spots)
- Large strap wrench or aforementioned compressor clutch puller.
- Wheel lug bolt socket (Snap-On 7/8" aluminum-lined #AS 281 pictured).
- Combination wrenches 10, 11, 13, 17, 19mm (2), small 10mm ignition wrench especially suited for removing compressor-to-cambelt cover ground bolt. Metric flare wrenches optimal for fittings.
- Jack & stands, wheel blocks

# [Be smart - always wear goggles or glasses when working on/under car and with refrigerants.]

Parts:

- Filter-dryer Ferrari #129101/114730 \$110-150 for canister + \$60 for switch. Replacement w/low-pressure switch Four Seasons #208625 (matches to 1980-86 Saab 900 8-valve engine); purchased locally at Carquest for \$63. Both OEM and replacement are identical & manufactured by Parker.
- York replacement compressor listed as 209/210 type #278108 (new)/#258108

(remanufactured) with proper suction/discharge port orientation and Rotoloc fittings; #278108 is \$330, #258108 is \$179. If you elect to replace the compressor will also need two 3/8 x 16TPI x 2in bolts to mount lower bracket (OEM compressor is specially threaded to accept metric fine-thread bolts for lower bracket, new compressor is standard coarse thread).

- York 206 front compressor seal kit from NAPA # 207243 \$18.33 or CCI #488-25274.
- York compressor gasket kit (all gaskets except front seal includes Teflon o-ringgs) #207120 \$16.90
- Teflon compressor port Rotoloc o-rings (2) NAPA # 207165 \$1.30/each.
- O-rings (specific for air conditioning applications) for any opened connections. Interestingly, all fittings were standard – not metric- sizes & threads; I purchased GM blue assortment kit 21-24657B (\$7.52) from ACKits.com to ensure I had any & all required.
- Nylog O-ring sealant \$5.50 from ACkits.com.
- Compressor oil (appropriate type for selected refrigerant: R-12/blend or R-134a) approx \$5 per quart also from ACkits.com.
- Schrader valve cores for compressor fittings (most recommend replacing at every major service; I did not as mine were only 12 months old). Will need installation tool (Craftsman tire valve removal tool works perfectly).
- Plastic cap for compressor ports x2 (typically accompany new compressor).
- Blue Loctite (removable via hand-tools, not the forever type).
- M10 x1mm (fine) thread nuts x2 to remove compressor studs. If you need to replace any
  nyloc nuts my local hardware store had all the correct metric sizes, albeit silver nuts with
  white or blue (not yellow) nylon rings.

Original Schrader valve cores & removal tool:



### References:

### <u>Printed</u>

Haynes heating & air conditioning manual #1480 308/328 factory technical specifications manual

<u>Internet</u> www.ccicompressor.com www.napaonline.com
www.ackits.com www.aircondition.com

Parts sources: NAPA

Carquest www.ackits.com

<u>www.oem-performance-parts.com</u> (cross-reference to Saab 80-86 8v filter-dryer) www.4s.com (Four Seasons A/C products website) Parker A/C Manufacturing (662) 728-3141 or www.parker.com

#### Simplistic Approach to Leak Testing

Most common reason for poor A/C performance is lack of refrigerant, either due to actual leak or slow loss over time. Clues to system charge are sight glass window (located on top of filter-dryer; clear if completely discharged, bubbly if partially charged, and oily if desiccant breaking down) and (with car off) briefly depressing high-side Schrader valve to see if system pressurized (realize venting refrigerant into atmosphere is technically illegal). If system appears completely discharged, next step is to verify integrity by evacuating system. Connect the gauge set with engine cold (challenging but possible with intake ducting and airbox in place) by reaching under the airbox to remove both black plastic schraeder valve caps. Connect the high-pressure hose to the upper (discharge) fitting and low-pressure hose to the lower (suction) fitting; if your system has been converted to R-134a hoses will snap onto adaptor fittings. I always put a drop of oil on each hose fitting gasket to enhance sealing. Connect the third hose to the vacuum pump, open both sides, and pull vacuum down to at least -25psi; if cannot accomplish this with vacuum pump in good working order you have a large leak somewhere & may actually be able to hear hissing (if so, proceed directly to specific component/hose repair). Unless extremely loose, fittings typically will not cause this magnitude of leakage. Close gauges, note reading, and wait 30 minutes. If vacuum remains unchanged, no leak is present & system can be recharged (or you can replace filter-dryer, re-test, then recharge). However should the pressure slowly return (increase to atmospheric), a leak is present somewhere in the system.

Finding this leak can be a challenge. Options include very sensitive electronic "sniffers" or my preference UV dye (much better than the old thick red dye) [some shops also pressurize with nitrogen or compressed air to 200-300psi and listen for leak]. System must be partially charged for dye or sniffer to work. Pull vacuum then close gauge set. Connect refrigerant to center hose and purge air from hose (open can then crack hose connector at gauges slightly until refrigerant comes out). Open both sides and allow pressures to equalize. Close off both sides and route hoses away from hot or rotating engine parts. Start car & allow to warm. Rotate A/C blower to high and thermostat to max cool. Open low-pressure side and add in remainder of refrigerant can to partially pressurize system – discharge pressures will typically be in 50psi range. Don't be surprised if compressor clutch doesn't engage until you add a bit of refrigerant – signifies low-pressure cutoff switch at filter-dryer is working properly. Turn car off, remove gauge set and connect UV dye cylinder with hose (purge dye hose per instructions) to suction fitting. Add in UV dye per instructions and remove connector hose; if adding to discharged system in vacuum I found easier to add about 5ml directly to hose connected to suction side (my hoses have inline

shut-off valves), re-connect to gauge set, then push in with refrigerant charge. Wear gloves to prevent your hands from glowing. Restart car & run with A/C on for about 15 minutes. Shut off and start tracing lines & components with UV light and yellow goggles. Really quite impressive how well this highlights, especially at night. Expect a slight amount of dye leakage from filling around suction input hose fitting.

If no obvious massive leak, proceed systematically from front of car. Look through the lower front spoiler grill to inspect the condenser (able to maneuver small UV light stalk through opening). Check over filter-dryer, along hoses, and all hose connections & crimpings. Remove the cowl covering (7-8 Philips screws around perimeter) to check around expansion valve. The evaporator core is not really very accessible but possibly able to remove blower resistor (in ducting above accelerator pedal) and be creative with inspection mirror. Some also recommend running car and checking if fluorescent dye leaks out of evaporator drain hose. The refrigerant lines run inside the frame rail along the passenger side & thus unless previous overcharge/rupture or accident typically well-protected from damage. Check lines attaching to compressor in engine compartment (need to remove airbox & ducting for thorough inspection). Compressor front seal is buried under magnetic clutch but UV dye around clutch or spray pattern on compressor body suggestive of failure. A problem I encountered was cleaning off dye after leak found – wipe it off immediately otherwise very stubborn to remove once dry. Scrubbing with isopropyl alcohol worked reasonably well.

My car had a loud hissing sound in engine compartment when pulling initial vacuum but I could not localize. Partially charged with UV dye and then obviously leaking around

magnetic clutch from front compressor seal (impossible to see once clutch installed).

# If you are unable to connect A/C gauges with airbox in place the steps for removal are:

First, block front wheels & loosen right rear while car is still on ground. I use an aluminum-lined socket and plastic freezer baggie to avoid damaging the lug bolts.

Jack the right rear up and support with stand/blocks under frame box tubing. Make certain car is very secure – not only are you going to be working underneath, but may want to run the car in neutral while supported.

Remove wheel. Inner fiberglass well liner is held on with 7 screws – 3 hex, 4 Phillips. Maneuver liner out by rotating forward and clearing fender lip:





Compressor is now visible. Remove the airbox top cover 5mm hex screws and set aside. Remove the airbox lower section (held to CIS airflow unit with large hose clamp accessed from below fender with 1/4" socket on universal; fortunately mine was only snug & I was able to wiggle off) and two hoses below:





The "s-shaped" fiberglass intake duct is held in place by one small bolt in wheel well and two 8mm hex screws in engine compartment below decklid support strut:

Remove and maneuver out of engine compartment.

Now both high and low sides are accessible to connect gauge set. If you choose to add refrigerant/UV dye and need to start car ensure gearbox is in neutral & temporarily replace airbox with air filter.

### **Replacing Filter-Dryer**

Once you have confirmed system integrity I recommend changing filter-dryer. Alternatively, if you do find a leak, repair that component and change filter-dryer then recheck system integrity. Access to this section of the system is not terribly difficult. Open front hood and

filter-dryer with pressure switch is visible in the right front with condenser below. Remove the perimeter screws and lift off the fiberglass cowl cover. Hoses run along the right fenderwell from the filter-dryer to the expansion valve and from the evaporator core returning to the compressor. Unfortunately no auxiliary service fittings are provided. The expansion valve-to-evaporator connection is covered in gooey black insulation. Evaporator core is buried under the middle aspect of the dash.

Considered good preventive maintenance to replace the filter dryer anytime the system is opened for service. With age some units have also been known to discharge their desiccant contents into the system and clog the downstream expansion valve/components.

To remove, first confirm system is depressurized. Hold both fitting & top square part of filter-dryer and slowly loosen (normal RH threads):





Note the o-ring on either hose – remove & cover both lines to prevent dirt in system. Disconnect the pressure switch wiring harness. Small 10mm bolt holds circumferential cylinder clamp in place:

Remove and cap both input/discharge fittings on filter-dryer to prevent oil leaking out. The

OEM unit on my car is a Parker #077942 that cross-references to Four Seasons #208625 available complete with canister & sensor from Carquest for \$63/NAPA \$58. Catalogs list as fitting 80-86 Saab with 8v engine; I have found online listings for \$31. OEM (left) and replacement (right) filter-dryers:

Close-up photos of Parker labels: OEM first then replacement:



Remember to add 1oz of oil to the system

(525 viscosity for R-12/HCFC blends or PAG for R-134a) when replacing. Can add either directly to new filter-dryer or into either line:

Fit new o-rings to each connection (blue GM #12):

I used Nylog sealant on both O-rings:





Lower new filter-dryer into circumferential clamp. "Seat" both lines to snug then install & tighten 10mm clamp bolt. Tighten both fittings securely now using 17 & 19mm wrenches, holding rectangular ridge on top of body of filter-dryer to prevent twisting. Re-connect low-pressure switch leads (connections are not specific, one lead to each terminal).

# **Removing Compressor**

This is the most difficult aspect of the job. Remove wheel, fender well liner, airbox & ducting as described above. Depressurize system. Remove both fittings from compressor and cap open lines & compressor to prevent oil leakage. If you plan to replace the A/C belt, will need to remove both alternator & water pump belts [see my article on accessory belts for removing alternator belt; water pump belt requires loosening pivoting tensioner & removing]. Loosen the A/C belt tensioner – top nut is 17mm and bottom 13mm, both with washers underneath – and set tensioner aside. Lower compressor bract has a lower 17mm nut easy to access but compressor lower bracket mounting bolt obstructs upper. I was able to use a 17mm socket on 3/8"universal with extension to loosen then used box end of ratcheting combination wrench from above to remove. Removing ascending coolant pipe hose clamp to allow slight movement may help but is not necessary. Compressor mounting bolts are 17mm; do not need to remove inner

prior to bracket removal. Take care not to lose the large flat washers that fit between the gray bushings and the compressor. Maneuver bracket out.

Disconnect the magnetic clutch power lead. A small 10mm grounding bolt facing directly

backwards at the top of the cambelt cover is best accessed with a small combination wrench (don't drop into engine compartment). Compressor is then held in with three 17mm nuts; I removed closest to firewall first followed by other two [17mm ratcheting combination wrench excellent for tight workspace]. Support the compressor from underneath then remove nuts. As the compressor drops down be careful not to lose large washers or "c-shaped" shims (one per stud). Remove all washers/bushings until top three studs exposed. I was unable to extricate the compressor from the engine compartment with these in place so using double-nut technique removed in-situ (not very tight). Rotate so magnetic clutch facing gas tank then lift & turn to maneuver out.

# **Compressor Front Seal Replacement**

Set the compressor/clutch assembly on the workbench. Clean any major deposits of road debris. Note orientation of the magnetic clutch leads – ground wire attaches to top right magnetic coil bolt (with flat as opposed to star lock washer) and leads towards body of compressor [leads should run towards right in picture – I initially installed incorrectly but for some reason forgot to photograph after I realized & switched]:



Metal ID tag on compressor reads:

No 18130 Pt 206R 20141 Refrig 4 87

Main pulley nut (note yellow torque marking in photo) is 14mm; special tools to hold the clutch while loosening exist, but I ran power to the clutch leads from a battery tender to engage pulley.

I then put a large elastic strap wrench around pulley and was able to loosen bolt (not very tight, perhaps 15 ft-lbs?). Unscrew almost to point of removal – I then turned compressor over and tapped around pulley with rubber mallet until clutch came loose – leaving bolt in place prevents from falling. If you have access to a clutch puller tool this job would be greatly simplified; the York uses a pliable rubber-esque seal but tapping on other compressors with ceramic seals potentially could fracture. Magnetic coil mount removes with four 11mm bolts.

Clean & set magnetic clutch components aside. Clutch appears to be proprietary part (stamped "Ferrari ") but unless magnetic aspect fails only working part is a bearing held in with snap rings that should be replaceable (could only discern "8148" marking on seal surface). Mine spun smoothly so did not disassemble further.

Compressor front seal was leaking. This is a York type 206 RH discharge compressor requiring seal kit for "6-bolt ¼" front plate" – NAPA part # 207243 or CCI # 488-25274. CCI kit is OEM with bolts & centering tool, NAPA kit has a few spare parts without bolts and unfortunately does not include instructions, so I installed new seal in manner old seal was removed (purchase CCI if you can find/order; both run about \$15-20). Front seal is spring-loaded, so apply gentle pressure with 7/8 deep socket [not illustrated] and loosen six perimeter ¼" bolts:

Neither these bolts nor the clutch hub bolt penetrate the compressor cavity so thread sealant is not required. Remove the circular front plate & note the large o-ring seal on back:

Next, carefully pry the seal components off the main shaft without scratching the shaft sealing surface:

My old seal came off in three pieces: a carbon washer, spring-assembly, and lower "hat-shaped" seal with encompassing thin metal ring:









BIV

Clean the front plate sealing surface – endeavor not to let debris enter the compressor front bearing. I then turned the compressor over and briefly polished the shaft with 600-grit sandpaper (holding upside down prevents any filings from falling into front bearing).

Remove the woodruff key by tapping gently with hammer until front end tilts upwards:





Liberally wipe down the shaft with refrigerant oil (either 525v mineral oil or PAG depending on what type of refrigerant you're going to use). The kit seal was two pieces – carbon (black) washer fits on top with small "step" on face upwards and edges fit into "tangs" on spring-loaded seal:





Coat the entire seal with refrigerant oil. Fit spring-loaded seal onto the shaft (with recess for carbon washer facing upwards) and press squarely downward with 7/8" deep socket to seat:

Carbon ring then fits on top, taking care to install with small "stepped" surface upward & edge detents aligned with seal:



Fit a new o-ring to the circular front plate (I coated this ring with Nylog sealant) and set on top:



On my compressor the "G.S.C." logo originally lined up with the body so I reinstalled in this orientation. Press the plate down gently with the 7/8" deep socket and install the perimeter 1⁄4" bolts and tighten symmetrically (per CCI torque to 5-8 fl-lbs if you're fortunate & own a microtorque wrench):



Rotate the compressor shaft a few times to lubricate the seal. Tap the woodruff key back into place:



Remove the suction & discharge port covers. Pry out both Rotoloc Teflon o-rings and replace with new NAPA parts #207165:

Note: I then assembled an apparatus to vacuum-test the new seal using vacuum pump, gauges, and two stem-type Ford service ports (from 1966 Mustang). At first air continued to leak around seal. After disassembling & reassembling several times suddenly was air-tight. I have no idea what I did differently – assembled as above x3 – perhaps the seal had to "seat"? Then pressurized with can of HCFC blend to 35psi without leakage.



Estimate amount of oil that dripped out of compressor during removal & add that amount back through the suction port (I guesstimated 1.5 ounces on floor). Recap suction & discharge ports. I then washed, dried & resprayed my compressor (Krylon dull aluminum, close match to flaking factory paint):



# **Compressor Replacement**

NAPA sells the York 209/210 (206-style with larger displacement) compressor for the 308/328 under part #278108 (new)/#258108 (remanufactured). Both are painted black [can respray to dull silver for OEM appearance] & have the correct upper discharge/lower suction ports to fit original lines properly. The new unit that NAPA pulled for me had correct endplate

with Rotoloc fittings & new Teflon o-rings but the rebuilt part had two adaptors to an o-ring endplate. I would prefer as few fittings as possible to minimize potential sources for leaks. I was quoted \$179 for remanufactured or \$330 for new, both with 1-year warranty provided customer replaces both filter-dryer & expansion valve concurrently & can provide proof system flushed clean by certified HVAC mechanic. Unfortunately if one performs this at home and cannot provide documentation apparently warranty is void.

#### Addendum:

The above replacement of front compressor seal held for about 6 months. I then found oil dripping from rear compressor plate & elected to replace compressor. The first compressor (#258108) I purchased had similar fittings to Rotoloc but were not correct; a second compressor had proper endplate. I sprayed with Krylon dull aluminum to replicate factory finish. On reinstallation, I found that the lower mounting bracket fittings on the OEM compressor were threaded for metric bolts on the bottom while the replacement #258108 used 3/8 x16 TPI on all mounting points. I purchased two 3/8 x16 TPI x 2in long grade-8 (so gold cad color would match original hardware) to use on lower bracket. Realize if you ever

need to disassemble these will require 9/16" wrench & all other fasteners are metric.

# Reassembly

Replace the magnetic coil and tighten four 11mm bolts – I used blue loctite on these threads. [This photo is incorrect; leads should run off right of magnetic coil mount and along compressor body]:



Fit the pulley assembly over keyway, reenergize clutch, hold with strap wrench & tighten 14mm center bolt. Could not find specific torque in factory manual but found one reference to 10-12ft-lbs, again with blue loctite on threads:



De-energize clutch. Spin the center section and outer pulley 360 degrees & ensure neither contacts magnetic coil.

Maneuver compressor back into engine bay. I found this was easiest by starting with clutch pulley facing away from cambelt covers then lowering into area beside gas tank. Once in vicinity, there is sufficient room to rotate into correct orientation. Using the same doublenut technique as for removal, install three studs into compressor body - I used blue loctite to mount studs to compressor:



Put fasteners in proper sequence: "c"-shaped washer - large washer – lower cushion with sleeve - onto each stud:





<u>Important: install the compressor belt loosely over pulley before affixing compressor in</u> <u>position</u> – there is insufficient slack in belt to do so after installed, in which case you have to loosen compressor once again (don't ask how I discovered this). Working by myself, I lifted the compressor into place and temporarily spun large washer and nut on the top to hold in

place while installing others. From top side, install rubber bushing - large washer – 17mm nyloc nut on each stud. Rocking compressor slightly & lubricating with Armor-All facilitates sliding bushings over sleeves:



Torque spec for these nuts is 14 ftlbs, but I was unable to get a torque wrench into tight space so tightened to "snug". Next, connect the clutch lead wiring and tighten ground onto cam cover; this same 10mm bolt holds the upper dipstick (again, take care not to drop this small bolt into the depths of the engine compartment):



Put the two large bolts through the lower compressor bracket bushing prior to installation (difficult to clear ascending water pipe otherwise). My cambelt covers had a small washer on each stud between



the cover & bracket:

Start both large bolts into compressor ears by hand to avoid cross-threading, then install washer – 17mm nyloc nut on upper & right bracket studs. Upper nut is particularly

challenging, as compressor mounting bolt obstructs access:

Tighten lower bracket-to-compressor 17mm bolts. A/C belt tensioner then pivots on left bracket stud (17mm) and lower cambelt cover stud (13mm) – center and right lower in above photo. Push upward until compressor belt tensions to 42 ft-lbs (used) or 48 ft-lbs (new) using Krikit belt tension



gauge. Tighten pivot and locking nuts. Reinstall ascending coolant pipe hose clamp if previously removed:



Ferrari issued a recall on the early 1986 cars due to interference between the upper hose crimping and fuel return hose, recommending the return hose metal line be bent downward to achieve 1⁄2" clearance. Mine were very close on 1988 car, so not certain if there was actually a production line change. Replace Schrader valves cores (if you choose to) at this point; valve unscrews counterclockwise with valve removal tool; reinstallation is reverse.

Once compressor is secured, remove caps and reinstall discharge (high-pressure) upper outflow hose and lower suction (low-pressure) hose. I used Nylog sealant on Teflon o-rings and tightened both fittings securely using 1 1/8" combination wrench:



I then pre-installed gauge set & pulled vacuum to confirm system integrity prior to recharging:



Maneuver intake ducting into position and secure to fender underside with 10mm bolt and to engine compartment buttress with two 8mm hex screws:



Refit lower airbox & air filter, remembering to install both hoses on underside (large hose clamp nut is 6mm nut & smaller 7mm):



After liberally coating the inside with Armor-All, I was able to slide the rubber bellows hose back over the intake ducting and airbox top. Tighten four 5mm hex bolts to secure airbox top:



Replace fenderwell fiberglass shielding using the three 10mm and four Philips-head

screws. Replace the wheel and seat bolts while on stand. Jack car slightly and remove stand. Torque wheel bolts to 72 ft-lbs:



# Evacuating & Recharging A/C

Attach vacuum pump to input line on gauges and evacuate system to minimum -25psi. Close off both sides and allow to stand for 30 minutes. If readings remain unchanged, system is secure. Some recommend pulling a vacuum for a further 30 minutes to evacuate all moisture, others recommend introducing a partial charge to system & then re-evacuating. If vacuum does not hold, you'll need to identify source of secondary leak (as per UV dye kit, above). Repair this leak then evacuate & check system again.

As previous, attach refrigerant can to input line on gauges. Pierce can and purge line with refrigerant. Open both high & low sides to allow refrigerant into system. When pressure stabilizes, close off both sides. After checking nothing is near rotating/hot aspects of engine, start car & allow to warm to operating temperature. Some recommend putting a fan in front of the condenser (RH front bumper) when testing A/C. Open low side and add refrigerant until can is empty. Full charge for 328 is 2.2 lbs (1kg) R-12 or approximately 14oz R-134a or 12 ounces HCFC blend (DuraCool/HC-12a). Interestingly, after adding 2 cans of DuraCool my high-side pressures were only in 100-

110psi range (typical R-12 system operates at 180-220psi). Sight glass showed bubbles (which I understand is common with HCFC blends even when fully charged) so I continued until high-side pressure read in 175-200 range (required 5 cans DuraCool in total). Sight glass was then clear. Turn off engine. To spill the least refrigerant, remove the low-pressure line immediately, allow engine to cool & pressures to equalize, then remove high-pressure line. Reinstall both Schrader valve caps. Congratulations & hopefully your A/C will work properly for at least a few years.

# Dash lights how to -1983 308 GTS QV-

By: Magnum

Hello Fchatters.

I've decided to renew my instruments panel, cleaning, adjusting and changing the bulbs. And I wanted to share the experience so I've charged the battery of my digital camera and here's the result: a dash lights refresh tutorial. I hope that you will find it useful.

#### Index:

- $\Box$  Step by Step
- $\Box$  Changing the dash bulbs
- $\hfill\square$  Bulbs needed
- $\Box$  Upgrading the dash lights
- $\Box$  Tips
- □ Extra

#### 1. Step by step:

1-Remove the steering wheel with a 3 mm T-Handle hex wrench. Be careful to not break the Allen screws –a little bit of W40 will help-.

2-Remove the four indicator lights on the corners –the two top yellow, and the two down red, with different functions depending the model year and version-. Do it with a plastic screwdriver or special tool for dashes, in order to avoid scratching the black paint. Also you can loop some dental floss around each indicator and pull out gentle. The lights come out very easy, with no big effort.



3-You must pull out gentle the lights and cables in order to have free room to reach the four screws inside the holes. With a screwdriver unscrew them –don't bother if they fall down, you will be able to pick them as soon as you remove the panel-.

4-Put your fingers inside the holes and pull out gentle the instrument panel. Be careful to harm the leather. And it's out!

Now you can dismount the speedometer, tacho and rest of the gauges to clean them up and change the whole bulbs.

#### 2. Changing the dash bulbs

With the instruments panel out, is easy to change the bulbs of the gauges. To change them you need only your hands and a very thin flat screwdriver... and the bulbs, of course! In the speedo, to pull out the white plastic bulbs socket you need to push up the part gentle with the screwdriver inserting it under the socket –see image-. In the rest of the gauges is very easy, so you can pull out the black/white sockets only by hand.

1-The speedometer has 5 small bulbs wedge type. Ref. Silvania 2723, Philips 12516



2- The tacho has 5 medium bulbs bayonet type. Ref. Silvania 3893, Philips 12929



3- The fuel gauge has 2 medium bulb. Ref. Silvania 3893, Philips 12929

4-The temperature gauge has 1 medium bulb. Ref. Silvania 3893, Philips 12929 5-The

oil pressure gauge has 2 medium bulbs. Ref. Silvania 3893, Philips 12929

6-For the indicator lights you will need 5 small bulbs –including the security belt indicator-. Ref. Silvania 2723, Philips 12516

7-Also you can change the bulbs of the clock and oil temp, placed down in the centre console. You must unscrew the 2 bolts and the 2 gauges come out easily. At the back you will found the bulbs socket. For the clock you will need 1 medium bulb. Ref. Silvania 3893, Philips 12929. For the oil temp gauge you will need 1 medium bulb. Ref. Silvania 3893, Philips 12929.

8-It's a good idea to polish all the Molex connectors and contact switch blades & receptors, surely oxidized. This will increase the conductivity and, of course, the voltage going to the bulbs, helping to increase the bulb brightness.



9-One last job to do is to bypass the dimmer switch, a rheostat. You must connect the yellow and white (or yellow, depending on versions) cables. You have to build a very easy bypass (shown below) with electric wire and two male connectors.



The rheostat.

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Cables to bypass on the dimmer –two yellow and the white one-.

# 3. Bulbs needed

-Medium bulbs 9 mm. 4W, Ref. Silvania 3893, Philips 12929:

# 12 units



-Small bulbs 5 mm. 1,2 W wedge type, Ref. Silvania 2723, Philips 12516:



#### 10 units

# 4. Upgrading the dash lights

#### LEDS -light emitting diode-

I've tested changing the traditional incandescent bulbs for leds, and the result has been partially fantastic! I've used for the small wedge type bulbs –found on the speedo and indicator lights- ultra high bright leds with only one square superbright led –Image 1-, and the wattage is good enough to magnify the dash. These led are much brighter than the standard bulbs, and you can check it in the images. You don't need polileds lamps; single superbright led lamps are OK for the speedo For the small gauges, oil pressure, petrol level, water temperature, oil temp and clock, I've used the bayonet led type BA9s –Image 3- with only frontal LED, with normal results. The light intensity is a little bit better than the standard incandescent bulb light. Best with polileds around –Image 2-.



**IMAGE 1** Speedo small wedge bulb type. At the left the bulb LED replacement. At the top right the standard bulb.





**IMAGE 2** Polileds BA9 LED seems to be good for the gauge lighting. For a correct tacho and small gauges lighting, is very important that the polileds are placed around the bulb not in front.

**IMAGE 3** For the tacho I've used BA9s LED lamp bayonet type with 6 chips LED in the front, 1W. The light spread in the tacho and small gauges is not as good as seen in the speedo. Better to use it only for the indicators (turn, high beam, low fuel).



**IMAGE 4** Some of these BA9S polileds bulbs are too long to fit the incandescent bulb room, as example, on the clock. Check the length before buying.

**ATTENTION**: The LED operates at 12V with polarity protection. If the bulb does not light up after install, simply reverse the direction. Check it before assembling the dash!!!!!!

#### Change your light dash colour from green to blue

If you use cool white leds, the dash change his colour from green to blue. If you use warm white leds, the green standard light remains without changes –but brighter! The explanation: the instruments gauges have a blue coloured transparent plastic inside, to colourize the bulbs light. An incandescent bulb emits warm white, a little bit yellowed, so the yellow light with the blue plastic results in green dash light as you see in your 308. If the leds are cool white –no yellow light-, the blue plastic acts and colourize the gauge in blue. Spectacular!!!



LED light compared to incandescent bulb. Left side: LED, Right side, standard incandescent bulb.



Look at the final result on the speedo. The two cool white LEDs give a blue colour light now instead of green colour light.



The final result on the tacho with BA9s LED lamp bayonet type with 6 chip LED in the front, 1W . Blue colour light now instead of green colour light but very dim.

> Comparison between LED and standard bulb on the turn indicators. The exposure time is the same in the two shots. No tricks.

#### **5.** Conclusions

-I recommend changing the speedo –lighting and indicator lights- incandescent bulbs for the LED wedge type bulbs –shown earlier-. They emit less heat and brighter light.

-For the bayonet BA9s type bulbs found on all the other gauges I recommend using front type LED on the indicators, and polileds for gauge lighting.

-Some BA9s poliled bulbs are too long for the incandescent bulbs room on the small gauges, like the clock or oil temperature. Check it!

-For a correct tacho and small gauges lighting, is very important that -on the BA9s polileds- the leds are placed around the bulb not in front.

# 6. Tips

-Clean the Molex contacts and blades. -Put a little bit of Stabilant to enhance the contact if necessary.

#### 7. Extra

#### How to disassemble the speedometer

You need a flat thin screwdriver and patience. To release the gauge from the instrument panel you only need to disengage the electric cables –pull out the Molex connectors- and after unscrew the two aluminium nut –easy to do with your fingers-.

If you need to clean the inside you must proceed as the same way I explained in the Veglia clock restoring thread. You must to force gentle the chromed label ring, in order to free it from the white plastic gauge.

As soon as you loose the chromed ring you will have out the ring with the black plastic bezel, the glass, a black thin seal and the second black plastic part that is placed inside the gauge and over the dial. On the other hand you will have the speedo gauge.



If you want to release the speedo mechanism, you must unscrew the 3 screws on the back of the gauge. ATTENTION: if not necessary, avoid this last operation. Reinstall the mechanism inside the gauge will be very difficult –mainly to insert the end of the knob speedometer trip control-.



Clean whatever you need and go back with the instructions to assembly the speedometer. You must be very careful moulding back the chromed ring around the speedo gauge white plastic in order to not crack it and to not harm the chromed ring. Protect the upper face of the chromed ring with a thick plastic piece -2 mm thickness is OK- in order to use small pliers to do pressure.