

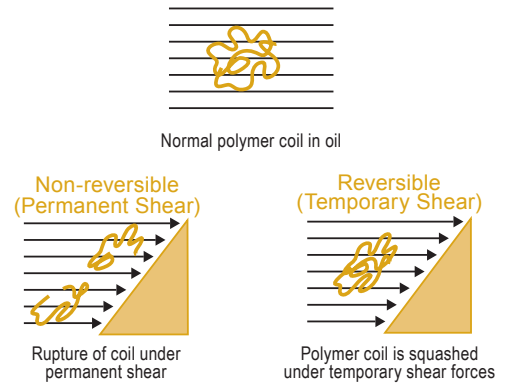


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PERMANENT VS TEMPORARY SHEAR

The below diagrams show the two types of shear that can occur with viscosity index improvers (VII). Permanent Shear is defined as the physical breaking apart of the polymer into smaller pieces and hence the oil suffers from a permanent loss of viscosity. Temporary shear occurs when the polymer is squashed but does not break apart and hence "springs back" to its original size after going through the area of high stress.

The shearing effect occurs when the oil is forced through areas of tight clearances or is "squashed" (eg cam lobe to follower) and if the gap is too small, then the polymer will rupture.



Penrite's 10 Tenths Racing range are formulated "shear free" and do not use any polymers but use special oil combinations to achieve the desired viscosity grades. As such, there are no components in the oil that can suffer from Permanent shear so the oil holds its original viscosity for the life of the oil drain.

Modern Base Oils

Current trend is toward Group II and Group III

- Separation process - Conversion process
- Hydrocracking with (wax) hydroisomerization provides greatest flexibility
- Hydroprocessing technology can be integrated with existing solvent refineries
- Slack wax and Gas to Liquids (GTL) products can be used to produce base oils similar to PAO.



Group I

Solvent Refining Separation process

- Remove Aromatics
- Remove Wax
- May include "Hydro Finishing"

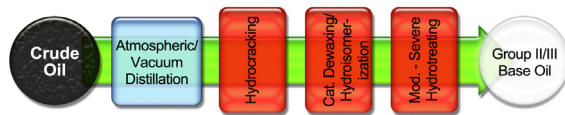




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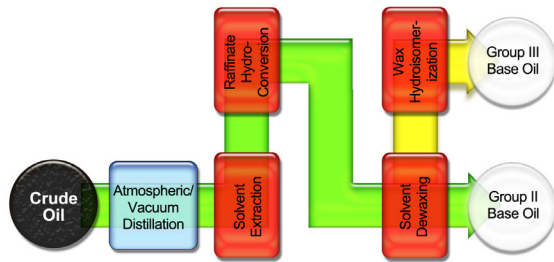
Primary process for Group II/III base oils is all Hydroprocessing

- Molecular conversion
- Hydrocracking
- Catalytic dewaxing (wax cracking)
- Hydroisomerization



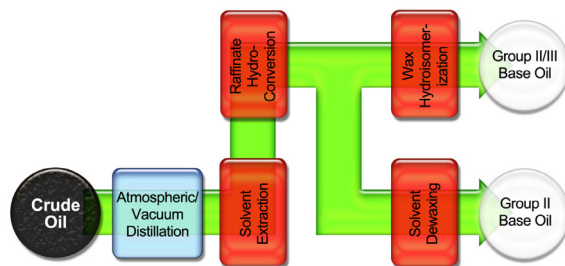
Slack Wax Hydroisomerization

- Production of high VI Group III base oils
- Production limited to slack wax availability and quality



Hybrid Process

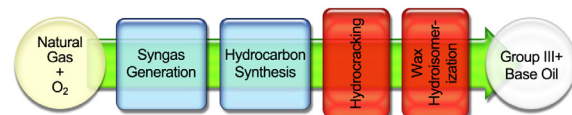
- Utilizes existing Group I plant
- Wax production can be maintained
- Increased VI via hydroprocessing of solvent extracted material
- Relatively mild conditions vs. Hydrocracking
- Dewaxing can be either solvent or catalytic



Dewaxing can be either solvent or catalytic

Gas to Liquids (GTL) Conversion

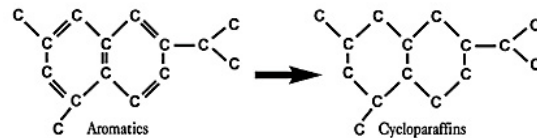
- Technology for converting methane to liquid products
- Sulfur and nitrogen free
- Very low aromatic content
- Products are very much like PAOs.



Hydroprocessed based oils – what do they look like?

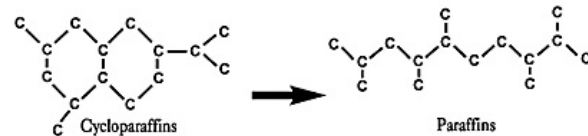
Group II

- 400°C
- >500 psi H
- Removes sulfur & nitrogen
- Converts aromatic hydrocarbons to cycloparaffins.



Group III

- 425-430°C
- 1,500-3,000 psi H
- Converts cycloparaffins to paraffin chains





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SYNTHETIC BASE OILS – MAN MADE TYPE

PAOs – Poly alpha olefins

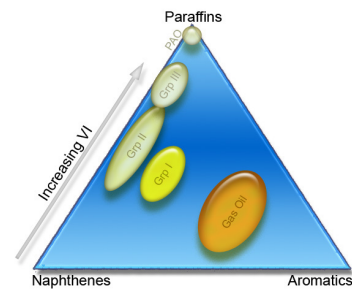
PAOs are derived from the oligomerization of 1-decene

1-decene is derived from the oligomerization of high purity ethylene (C₂H₄)

PAOs are extremely pure

- Identical molecules
- No sulfur or phosphorus
- No wax

So from a "purity perspective", the graph looks like this.



Esters

Manufactured by reacting an acid and an alcohol to give ester plus water.

Principal Types of Diesters

- Adipates, Phthalates, Azelates, Sebacates, Principal Types of Polyolesters
- Glycols, Trimethylolpropane (TMP), Pentaerythritol (PE)

How does a differential work?

The wheels are connected to the differential unit via half shafts. Power from the transmission drives the pinion gear which in turn drives the ring gear.

The ring gear is connected to 1 or 2 pairs of smaller bevel gears (known as spider gears), and ultimately power is transferred to the wheels.

It is these smaller bevel gears that form the heart of the differential unit: a mechanical device that detects when one wheel is turning faster than the other, and uses the spider gears to absorb the different speeds of both wheels and allow smooth cornering.

Types of differential

The most basic type is an :-

Open differential:

- Under good traction, it applies the same torque to both wheels
- However when traction is poor and one wheel slips on ice or mud, the slipping wheel will receive all the torque whilst the other wheel receives none, even though it does have grip.

Limited Slip differentials are better in poor traction conditions:

- Similar to open differentials but they have clutch packs inside the differential carrier, which apply friction between the side gears and the carrier.
- The friction from the clutches encourages the side gears to turn at the same as the differential carrier.



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- When torque is applied under slippery conditions, friction from the clutch packs prevents the wheel with little traction from spinning wildly and ensures that some torque is transmitted to the other wheel which has grip.

Locking differentials contain a mechanism to fully lock both halves of the axle at the same speed:

- Must not be locked on a hard surface, but quite common to improve traction in heavy trucks, especially in poor weather conditions and off-road applications.
- Locking differentials may be automatically activated (when the difference in wheel speeds reaches a given point) or driver-actuated.

Torque Sensing or Torsen differentials

- These tend to be complex arrangements of spur, helical and/or bevel gears, which prevent extreme differences in wheel speeds, therefore maintaining useful traction at each wheel all the time.
- They do not use clutches or electronics, so are both reliable and durable, and are used in many rear, front and centre differentials.

Centre differentials manage the power split between front and rear axles or axle pairs, in vehicles with more than one drive axle:

- Centre differentials can be any of the above mentioned types, or can be a viscous coupling similar to a torque converter in operation.

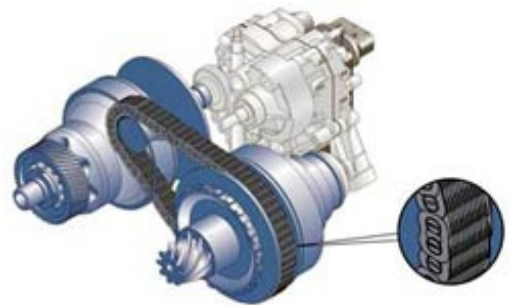
Limited slip differentials with electronic control

Similar to Limited Slip differentials with clutch packs to prevent slipping of one wheel. The friction of the clutches is controlled externally using sensors at the wheels to detect slipping. The hydraulic pressure needed for the clutches is electronically controlled.

HOW DOES AN AUTOMATIC TRANSMISSION WORK?

Automatic transmissions do not have a solid style conventional clutch like manual transmissions. Instead, they use a fluid coupling called a torque converter to transmit power from the engine to the transmission.

The changes in the ratios by the planetary gear sets (as distinct from hypoid or bevel type used in differentials or manual gear boxes), are done through the combined use of multiple disc clutches, one-way clutches and bands. These are the friction elements. The shift points are now electronically controlled (instead of simple hydraulic pressure) and these electronics in the valve bodies are also reliant on the oil.





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HOW DOES A CVT WORK?

A CVT (continuously variable transmission) is different again. There are two types of CVT. They both work on the basis of keeping the engine at the most efficient rev range for power and economy.

Traditional automatic transmissions use gears. Continuously variable transmissions don't have a gearbox but they operate on an pulley system that allows an infinite variability between highest and lowest gears with no discrete steps or shift.

Most CVTs only have three basic components:

- A high-power metal or rubber belt
- A variable-input "driving" pulley
- An output "driven" pulley

The variable-diameter pulleys are the heart of a CVT. Each pulley is made of two 20-degree cones facing each other. A belt rides in the groove between the two cones. V-belts are preferred if the belt is made of rubber.

When the two cones of the pulley are far apart (when the diameter increases), the belt rides lower in the groove, and the radius of the belt loop going around the pulley gets smaller. When the cones are close together (when the diameter decreases), the belt rides higher in the groove, and the radius of the belt loop going around the pulley gets larger. This is how it "changes gear". CVTs may use hydraulic pressure, centrifugal force or spring tension to create the force necessary to adjust the pulley halves.

Variable-diameter pulleys must always come in pairs. One of the pulleys, known as the drive pulley (or driving pulley), is connected to the crankshaft of the engine. The driving pulley is also called the input pulley because it's where the energy from the engine enters the transmission. The second pulley is called the driven pulley because the first pulley is turning it. As an output pulley, the driven pulley transfers energy to the driveshaft.

Both types put specific strains on the oil and it must be very shear stable. Penrite CVT Fluid V is our primary recommendation for most CVTs, but there is no Penrite product for European CVTs (that use "Luk" chains, eg VW/Audi), at this stage. General Motors and VW are among those manufacturers who have specifications for these oils.



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HOW DOES A MANUAL TRANSMISSION WORK?

The purpose of a transmission is to provide different ratios of speed between the crankshaft of the engine and the output shaft leading to the final drive. A clutch separates the engine from the driveline to allow the vehicle to drive away and change gears. The number of gear sets depends on the number of ratios provided.

The gears on the Main Shaft are free wheeling and in constant mesh with the gears on the Counter Shaft. To select a ratio the respective gear on the main shaft is connected to the shaft after synchronising the speed of the gear to the shaft. Synchronising is necessary to prevent clashing.

In low ratio the speed of the engine is high relative to the speed of the car. This provides power for driving away, acceleration and hill climbing. In direct (4th) gear both input and output shafts are running 1:1. In highest gear (5th, 6th or overdrive) the output shaft is turning faster than the crankshaft providing lower noise and fuel saving but less power.

How does gear selection work?

Following the route of power from the engine, the Input Shaft is connected to the 2nd gear via the dog clutch. As the 2nd gear is in constant mesh with the corresponding gear on the counter shaft the power is transferred to the gear set at the end of the Counter Shaft. Here the power is guided to the Output Shaft.

To engage a gear smoothly the clutch between engine and transmission has to be opened. Then both the Input Shaft and the 2nd gear need to be brought to the same speed. This is the purpose of the Synchroniser Ring. The synchroniser ring builds up friction between the synchroniser hub (connected to the input shaft) and the cone on the 2nd gear.

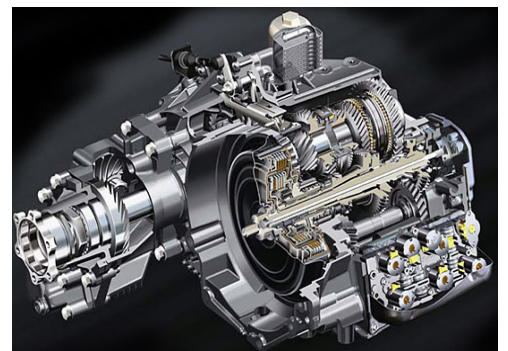
As soon as the speeds of hub and gear are equal full engagement can occur. The clutch can be closed again and power can flow.

Other types of Manual Transmission include: Automated Manual Transmission (AMT) - a manual transmission where shifting and clutch operation is done by hydraulic or electric actuators under electronic control. Double Clutch Transmission (DCT) - an AMT modified to allow shifting without torque interruption. This is achieved through employing 2 clutches and an additional countershaft.

what is a dual clutch transmission?

A Dual Clutch Transmission (DCT) is effectively two gearboxes in one. Two clutches to eliminate shift shock - one closes as the other opens

Sophisticated electronics and hydraulics control the clutches, just as they do in a standard automatic transmission. In a DCT, however, the clutches operate independently.





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Fact Sheet

December 2011

One clutch controls the “odd” gears), while the other controls the “even” gears). Using this arrangement, gears can be changed without interrupting the power flow from the engine to the transmission. The gear shafts have constantly meshed gears and synchronisers, so the driving style is very like a conventional automatic transmission.

Some DCTs use a wet clutch system and some use a dry clutch system - so slightly different oils are required.

Advantages :

- No torque loss or limitation
- Overcomes “shift shock” associated with the more conventional automated manual transmissions.
- Fuel efficiency: +15% vs 5-speed stepped automatic transmissions.
- Uses existing manual transmission manufacturing facilities
- Better acceleration than a manual transmission
- Size

The most common DCT at the time of writing is a six speed unit used by the Volkswagen group. They call it a DSG transmission. VW have also launched a new seven speed DSG.

It is felt that these will become widely used and across a wide range of vehicles. High performance vehicles made by Ferrari and BMW (large capacity, high output engines) will be released shortly with a DCT.

