AFRICA MICRO MARKETING

LUBES TECHNICAL TRAINING

27 MARCH 2018

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol

WHAT WILL WE LEARN IN THIS SESSION?

We will learn about:

- **Lubricant Functions**
- **Lubricant Base Oils & Classification**
- **Additives**
  - **Oil protectors**
  - **Surface Protectors**
- **Lubricant Properties**

LUBRICANT BASICS

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

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WHAT RIGHTS DO LUBRICANTS HAVE?

JUST LIKE HUMANS, LUBRICANTS ALSO HAVE RIGHTS

- Lubricants are part of our everyday business and hence they need to be handled properly and carefully.
- Hence, it is important to follow the right principle of lubrication, also called as the 5 R's of lubrication.
- What are the 5 Rights of lubricants?

'RIGHT LUBRICANT' in the
'RIGHT PLACE' at the
'RIGHT TIME' and
'RIGHT AMOUNT' with the
'RIGHT ATTITUDE'

WHY ARE LUBRICANTS USED?

A lubricant

- Reduces friction, making it easy to move one surface over another
- Reduces wear and tear
- Reduces the heat generated
- Reduces the noise generated

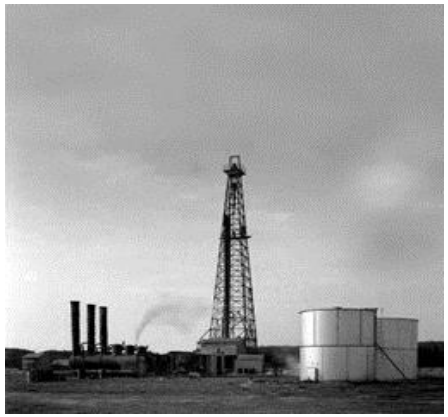
Additionally, a lubricant

- Acts as a coolant
- Removes the wear and tear particles and prevents damage
- Protects from corrosion and rusting
- Keeps contaminant suspended in oil
- Acts as a seal

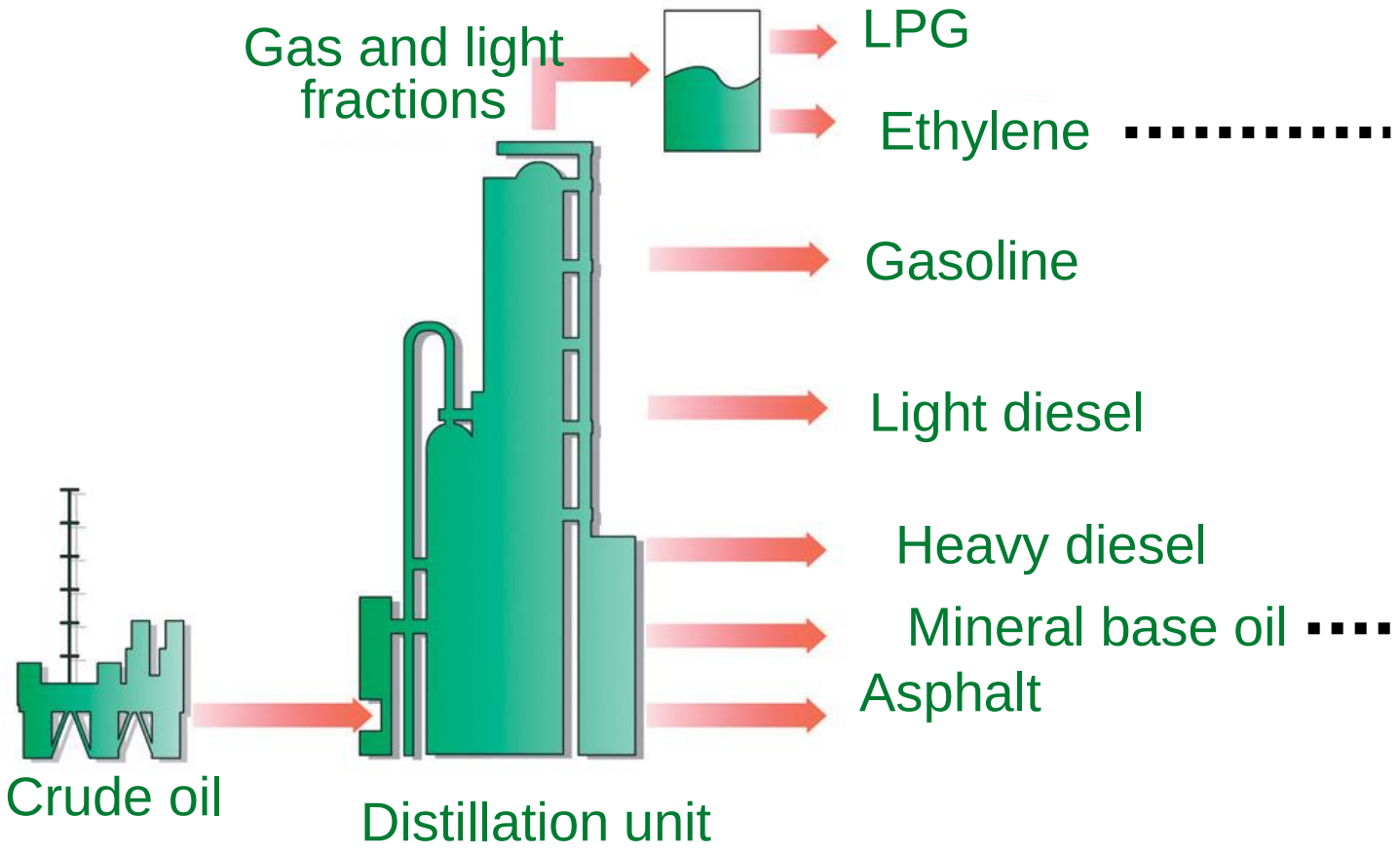
HOW OILS ARE MADE

Conventional/mineral refined from crude

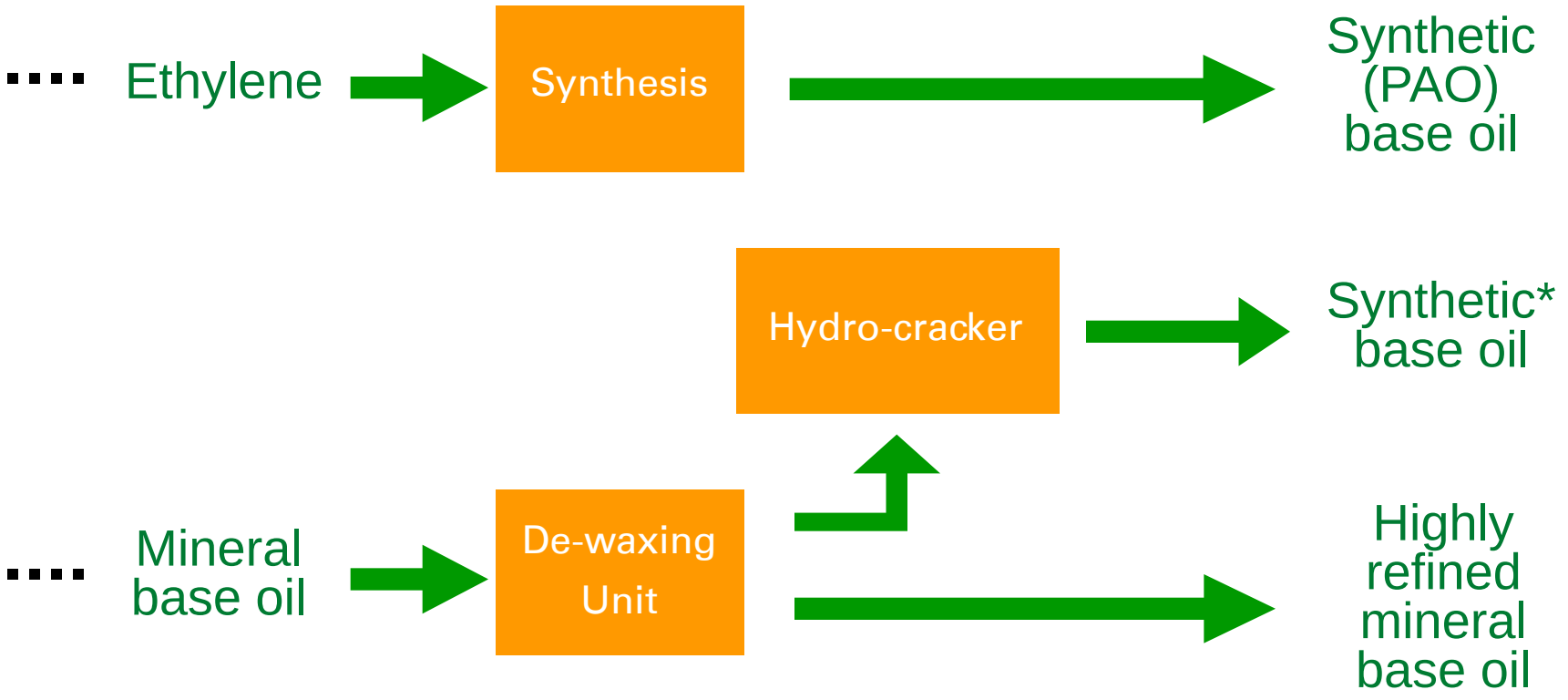
- Undesirable compounds removed (hydro finishing)
- Some hydrocarbons extracted or converted (hydro cracking)
- Synthetics – mostly polyalphaolefins (PAOs) - come from the purest part of the mineral oil refraction process, the gas – a difficult and costly process
- Semi-synthetics - a blend of conventional mineral base oils in combination with severely hydroprocessed synthetic stocks
- The base oil part of the lubricant could be any one of these types, either alone or in combination:
    - Mineral
    - Hydrocracked
    - PAO



FRACTIONAL DISTILLATION

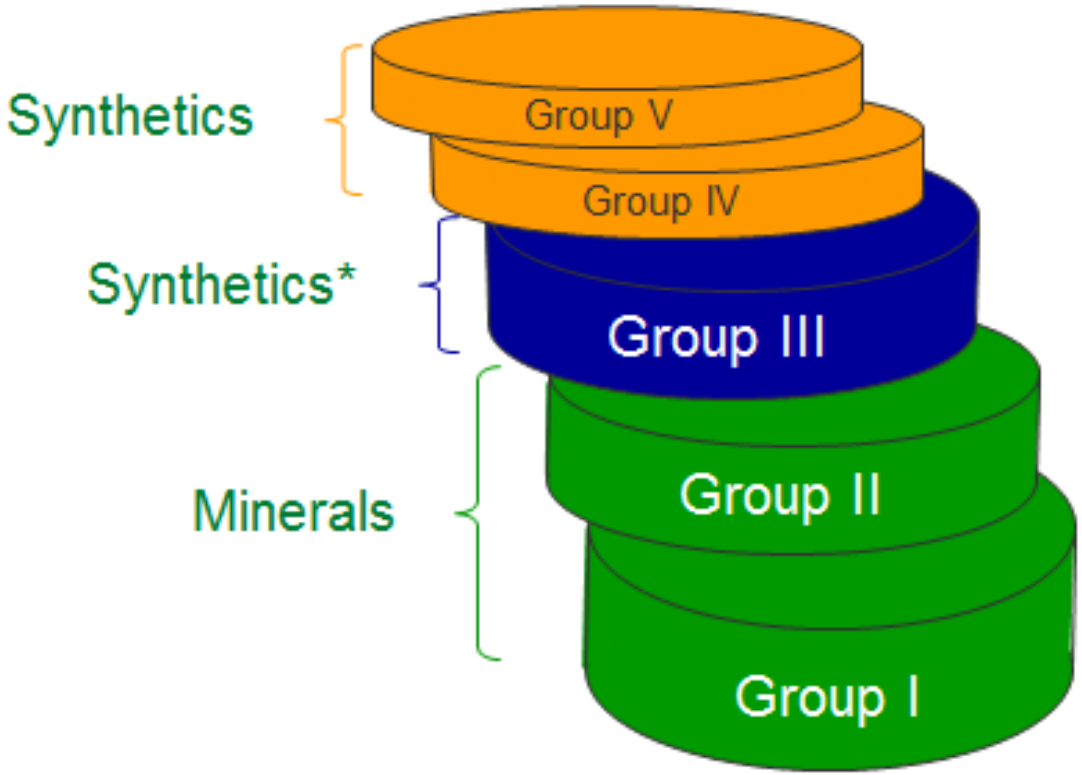


MINERAL & SYNTHETIC BASE OILS



BASE OIL CLASSIFICATION

- Mineral and Synthetic are general groupings.
- API Base Oils Groupings provide more detailed classification:



WHAT DOES A LUBRICANT CONTAIN?

A Lubricant contains **Base oil** and **Additives**.

Base oils are product of crude oil refining.

What are the two types of base oils?

- **Mineral**
- **Synthetic**

What are the two types of synthetic oils?

- **Group III Base oils - Hydrocracked**
- **Group IV Base oils - Polyalphaolefins** (PAOs) are a common example of a synthetic base stock.
- **Group V – PAG, Esters, etc.**

MINERAL VS. SYNTHETIC

Key difference between mineral and synthetic base oils:

- Conventional base oil is made using refining techniques to remove or reduce undesirable components
- Synthetic process is far more extensive, **altering the chemical structure** of the base oil
  - Select feed stocks
  - Rearrange
  - Break down molecules and re-build

ADVANTAGES OF SYNTHETIC OILS OVER MINERAL OILS

Synthetic base oils are “tailored” to provide consistent & predictable superior performance

- High Quality ingredients
- Purer and cleaner oil
- Oxidation Resistance
- Extended drain
- Excellent performance over a range of temperatures (high VI)
- Ability to flow easily at low temperatures
- Lower volatility
- Better shear performance
- Better sludge and deposit protection

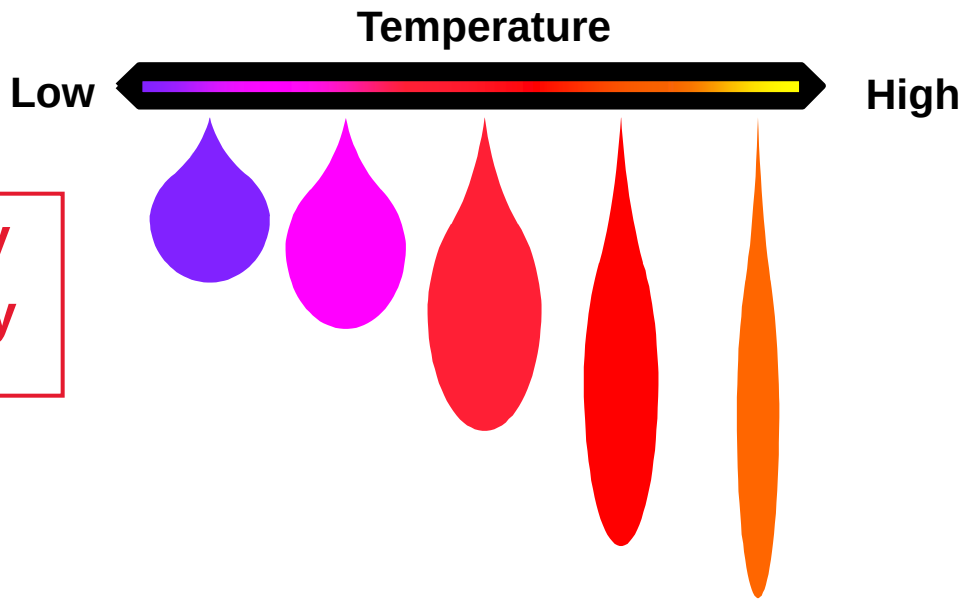
WHICH ADDITIVES ARE ADDED TO BASE OIL?

Modifiers *Modify oil properties*	Oil Protectors *Protect oil*	Surface Protectors *Protect Engine Internals*
• Viscosity Index Improvers • Pour Point Depressants	• Anti-oxidants • Anti-foam	• Detergents • Dispersants • Anti-wear • Extreme Pressure • Corrosion Inhibitor

WHAT IS THE RELATIONSHIP BETWEEN VISCOSITY & TEMPERATURE?

VISCOSITY VARIES AS THE FLUID TEMPERATURE CHANGES.

- **High temp = low viscosity**
- **Low temp = high viscosity**



WHAT IS THE RELATIONSHIP BETWEEN VISCOSITY & TEMPERATURE?

So what happens to oil viscosity if its temperature decreases?

Viscosity 

It's Viscosity will increase

And what will happen to engine lubrication because of this?

Oil will not flow freely → Some engine parts may not get lubricated properly → Engine internals will get damaged

WHAT IS THE RELATIONSHIP BETWEEN VISCOSITY & TEMPERATURE?

What happens to oil viscosity if its temperature increases?

Viscosity ↓

It's Viscosity will decrease

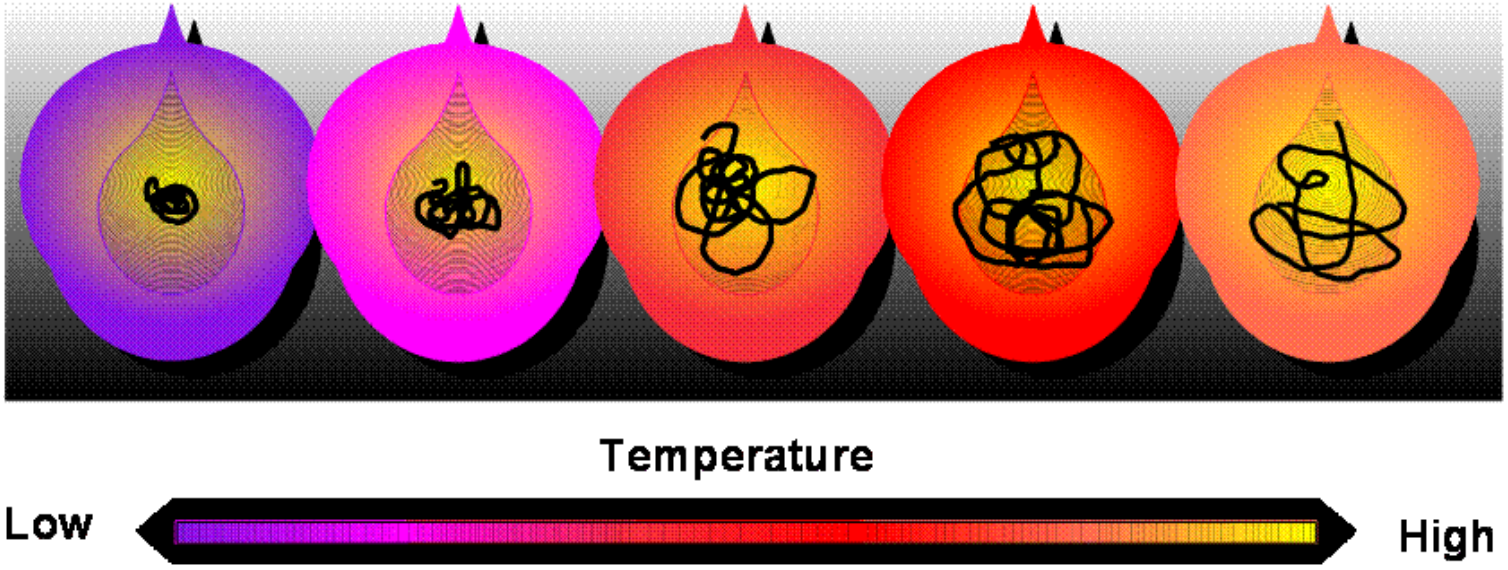
And what will happen to engine lubrication because of this?

The oil film will break → There will be metal-to-metal contact → Engine internals will get damaged

WHAT IS ADDED TO THE OIL TO MINIMIZE THE VISCOSITY VARIATION WITH TEMPERATURE?

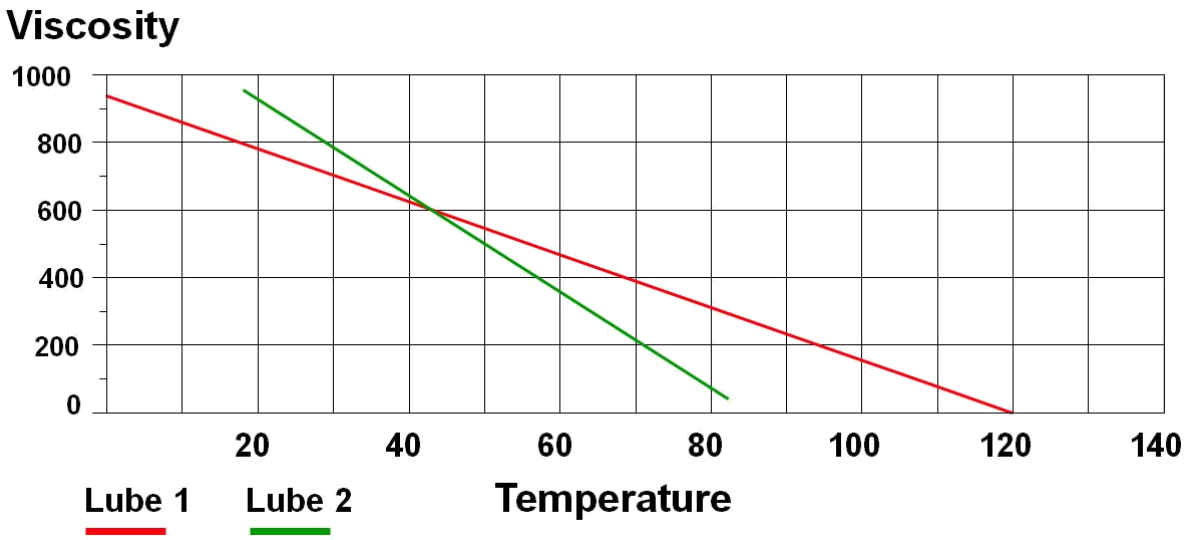
Viscosity Index (VI) Improvers

How does a Viscosity Index Improver work?



WHICH LUBRICANT WILL WORK BETTER IN VARYING TEMPERATURES?

Lubricant 1 will perform better than Lubricant 2.



Which parameter is used to measure the extent to which the viscosity of an oil changes with temperature?

Viscosity Index

WHAT WILL HAPPEN TO THE OIL?

The oil will freeze

What is added to the oil to prevent it from freezing?

Pour Point Depressant

It keeps oil liquid at extremely low temperatures.

How?

It lowers the pour point of the oil, thus preventing its crystallization at low temperature.

WHAT IS THE DIFFERENCE BETWEEN THESE TWO OILS?

Oil 2 is thick and blackened due to oxidation.

- When heated, oil reacts with oxygen from air.
- It produces gum, lacquer, and varnish deposits which thickens the oil.

What can prevent this? How?

Anti-oxidant

- It slows down oxidation of oil.
- It reduces formation of deposits.

Oil 1

Oxidized Oil

Oil 2

WHICH OF THESE OILS WILL YOU PREFER IN YOUR VEHICLE?

Oil 2 is preferred than Oil 1 which is foamed

Foam reduces the ability of oil to:

- Lubricate
- Transfer the heat

Oil 1

Oil 2

What can prevent this? How?

Anti-foam additives

They prevent foaming by causing large bubbles to form

WHICH ADDITIVE IS ABSENT IN THIS OIL?

Detergents

- Are cleaning agents
- React with chemicals that would otherwise form sludge, gums, lacquers, and carbon deposits
- Neutralize acid (secondary function)

WHAT ARE THE ELEMENTS THAT CONTAMINATES OIL?

Oil may get contaminated with

- **Soot**
- **Wear particles**
- **Insoluble impurities**
- **Water**

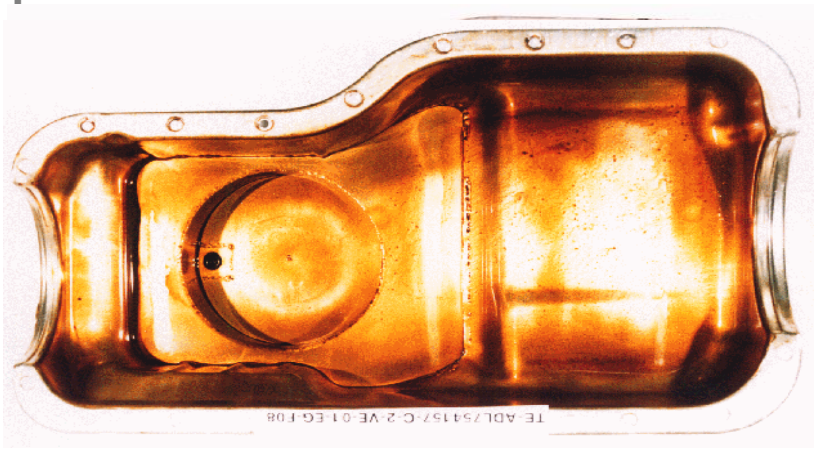
Which additive is used to avoid sludge formation?

Dispersant

It keeps insoluble contaminants in suspension.

What are the harmful effects of these contaminants?

They come together and form sludge, which gets deposited on engine internals, affecting engine performance.



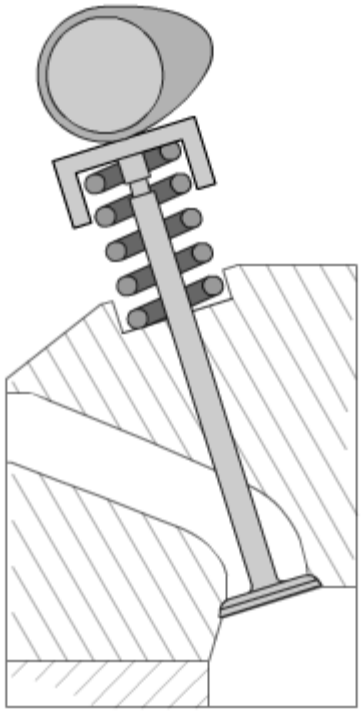
WHAT HAPPENS AT THIS SLIDING CONTACT ZONE?

Wear due to surfaces sliding against each other

What can prevent this? How?

Anti-wear additives

Anti-wear additives form a sacrificial layer at the sliding contact zones which prevents metal-to-metal contact.



WHAT CAUSES RUSTING & CORROSION OF METAL PARTS?

- **Water reacts with metal, causing it to rust.**
- **Acidic materials react with metal, causing its corrosion.**

What can prevent this? How?

Corrosion and Rust inhibitors

- **They neutralise acids**
- **They form a protective layer on the metal surfaces, thereby preventing their contact with water and acids.**

EXTREME PRESSURE (EP) ADDITIVES:

WHAT IS THEIR FUNCTION?

EP additive:

Prevents metal-to-metal contact under high load conditions.

Example: Gears

How?

It forms a sacrificial film of lower shear strength at high temperatures.

TOTAL BASE NUMBER AND TOTAL ACID NUMBER OF OIL

Total Base Number (TBN)	Total Acid Number (TAN)
TBN is a measure of the reserve alkalinity of a lubricant to neutralize acids formed by the combustion process.	TAN is a measure of the total acidity of the oil. It is defined as the amount of potassium hydroxide needed to neutralize all or some of the acid content.

VEHICLE SYSTEMS

WHAT WILL WE LEARN IN THIS SESSION?

We will learn about:

- How do the various systems in vehicles work?
- What are the different types of lubricants used in these systems?
- Which Castrol products are recommended for these systems?

VEHICLES SYSTEMS AND LUBRICANTS

Engine

Engine Oils

Transmission System

Gear Oils

Braking System

Brake Fluids

Cooling System

Coolants

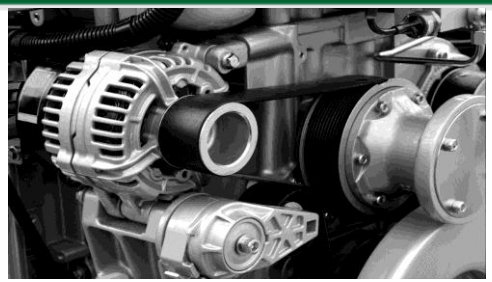
ENGINE OILS AND SPECIFICATIONS

Engine

Engine Oils

ENGINE BASICS AND SPECIFICATIONS

ENGINE OILS HAVE THE LARGEST SHARE IN THE MARKET. DIFFERENT TYPES OF ENGINES REQUIRE DIFFERENT TYPES OF ENGINE OILS.



AN ENGINE IS A MACHINE THAT CONVERTS ENERGY INTO MECHANICAL FORCE OR MOTION.

External Combustion Engine

- External combustion engines are not widely used anywhere nowadays, except for coal fired steam engine locomotives

Internal Combustion Engine

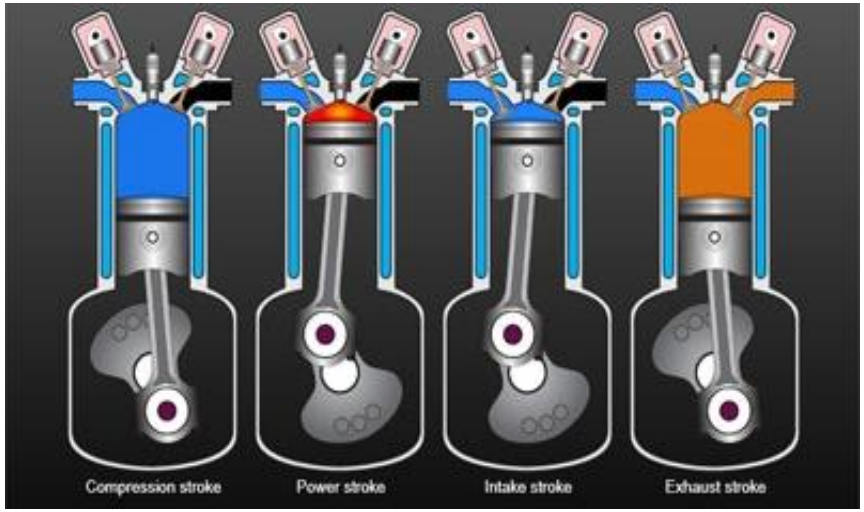
- Classification of Internal combustion engines:
  - **4-stroke engines** (Petrol & Diesel) some of which may be turbocharged
  - **2-stroke** Petrol & Diesel engines
- Modern automobiles are all IC engines. For passenger car applications, largely petrol engines are used and diesel engines are mainly used for heavy duty vehicles

WORKING OF A 4-STROKE DIESEL ENGINE

There are 4 strokes of the piston in one cycle of the engine:

- Stroke 1 – Intake
- Stroke 2 – Compression
- Stroke 3 – Power
- Stroke 4 – Exhaust

The piston travels the vertical length of the cylinder 4 times to complete one cycle – twice up & twice down.



4 stroke engines have 4 strokes & two rotations of the crankshaft per cycle.

WORKING OF A 4-STROKE DIESEL ENGINE

1

Intake stroke:

- Piston moves downwards, camshaft opens the inlet valve; air is taken into the cylinder
- Inlet valve is closed once the piston reaches its bottommost position called the Bottom Dead Center - BDC.
- Rotating crankshaft, forces the piston to move upward

2

Compression stroke:

- Air present in the cylinder is compressed by the piston
- Then just before the piston reaches its topmost position called the Top Dead Centre - TDC, diesel is injected in the cylinder by fuel injectors.
- The injected fuel when comes into contact with hot compressed air, starts burning.
- With the explosion of the fuel charge, high amount of energy gets generated inside the cylinder & the piston is pushed downwards again.

WORKING OF A 4-STROKE DIESEL ENGINE

3

Power stroke:

- During the power stroke, energy from fuel combustion is transferred to the crankshaft and the Fly wheel mounted on it
- Power stroke continues till the piston reaches its BDC
- The rotating crankshaft then forces the piston to move upward again

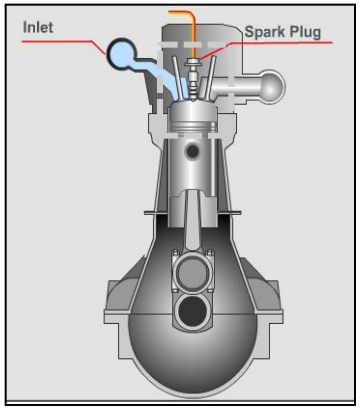
4

Exhaust Stroke:

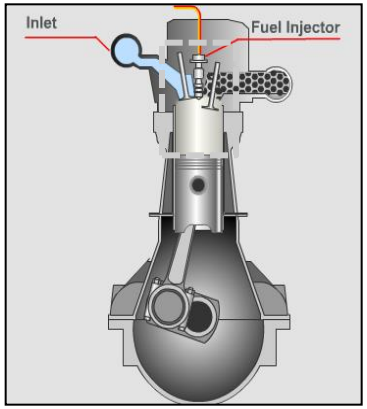
- Camshaft opens the exhaust valve & the piston while moving up, flushes out the exhaust gases generated in the cylinder due to combustion of fuel.
- Piston reaches Top Dead Centre & the cycle gets completed

What is the DIFFERENCE BETWEEN PETROL & DIESEL ENGINES?

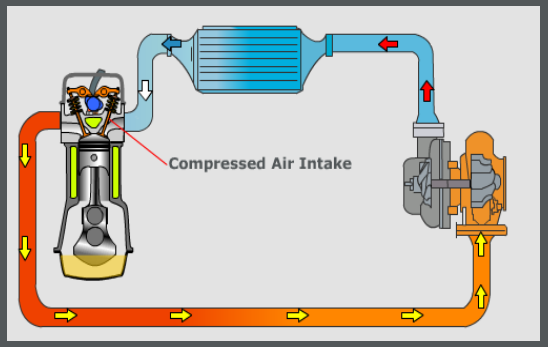
In a **Petrol engine**, charge of petrol and air mixture is let into the cylinder which is then ignited with the help of a spark plug.



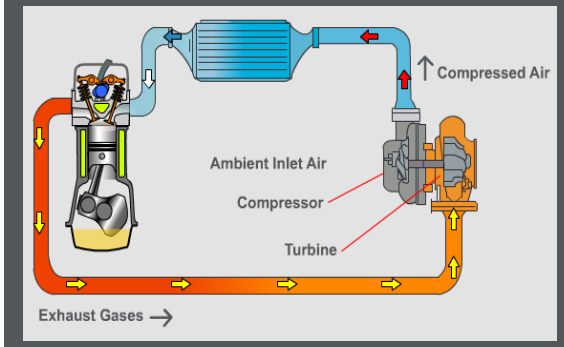
In case of **Diesel engine**, there is no spark plug. Only air is let in & towards the end of the compression stroke, diesel is injected in the cylinder by fuel injectors. The injected fuel when comes into contact with hot compressed air, starts burning & power stroke starts.



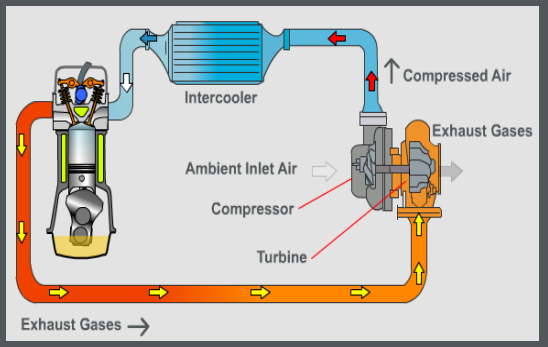
WORKING OF A TURBO ENGINE



- Takes compressed air into the cylinder in the intake stroke instead of atmospheric air.
- Compressed air increases the amount of air available for combustion
- Ensures complete combustion of fuel thereby generating more power for the same size of cylinder



- A turbocharger compresses the air before sending it to the engine cylinder
- It comprises of a turbine wheel & a compressor wheel mounted on the same shaft
- Exhaust gases coming out of the cylinder rotate turbine wheel at a very high speed
- The rotating turbine rotates the compressor wheel which in turn compresses the air

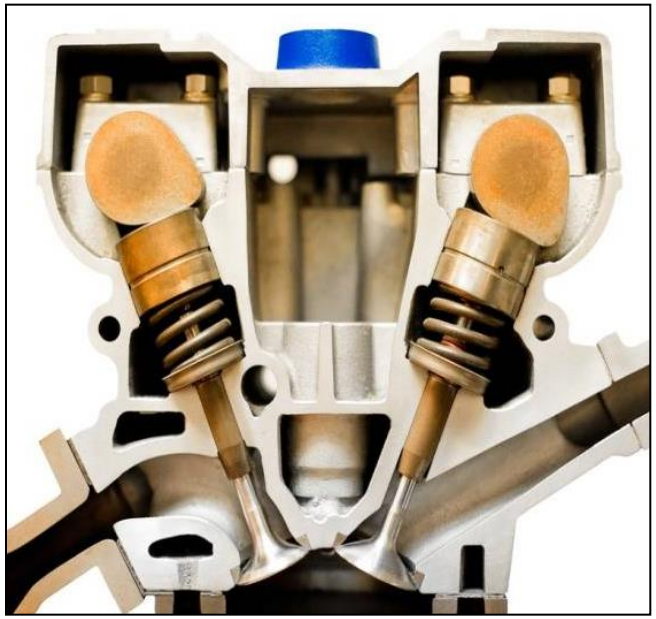


- The compressed air is then passed through an intercooler.
- Cooling of air increases its density which allows maximum volume of air to enter into the cylinder.
- A turbocharger's parts rotate at very high speeds therefore, it requires proper lubrication.

LUBRICATION IN IC ENGINES

The life & efficiency of an internal combustion engine reduces due to:

- Constant wear due to friction
- Accumulation of dust particles, deposits, rust in the engine cylinder
- Overheating of engine parts



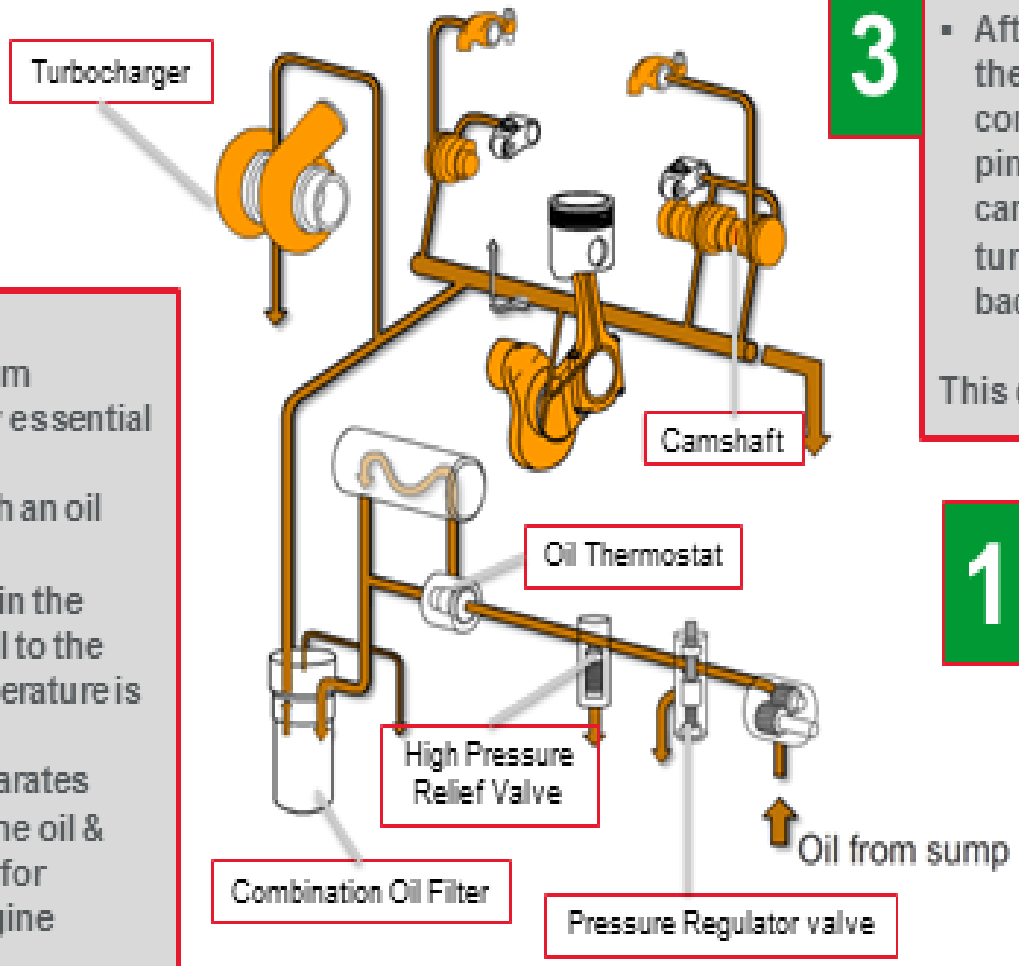
Sources of heat:

- Burning of fuel
- Friction between various moving parts

Oil is circulated as:

- Takes the heat away from hot engine parts
- The circulation prevents excessive heating of oil.

Lubrication system in AN IC ENGINE



2

- To prevent the oil from overheating it is very essential to cool it.
- Oil is passed through an oil cooler.
- A thermostat placed in the system directs the oil to the cooler if the oil temperature is high
- An oil filter then separates contaminants from the oil & sends clean, cool oil for lubrication in the engine

3

- After lubricating various parts of the engine like crankshaft, connecting rod, piston, various pin joints between these, camshaft, followers, & turbocharger, hot oil returns back to the sump.

This completes the oil cycle.

1

- Oil cycle starts when the gear pump takes oil from the oil sump.
- Oil is then passed through a pressure regulator valve.
- This ensures that certain pressure is maintained in the system always

WHY DO WE NEED SPECIFICATIONS?

- **From different kinds of base oils and additives, infinite varieties of lubricants can be developed.**
- **Can get very confusing for everybody unless the industry sets certain standards, to which everybody adheres.**

BASE OILS

+

What is a specification?

- A performance rating
- A range of tests or requirements with expected results

ADDITIVES

WHO SETS SPECIFICATION LEVELS?

Industry and Legislative Bodies:

ACEA

Association des Constructeurs Européens de L'Automobile

energy API American Petroleum Institute

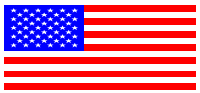
American Petroleum Institute

JAMA JAPAN AUTOMOBILE MANUFACTURERS ASSOCIATION, INC.

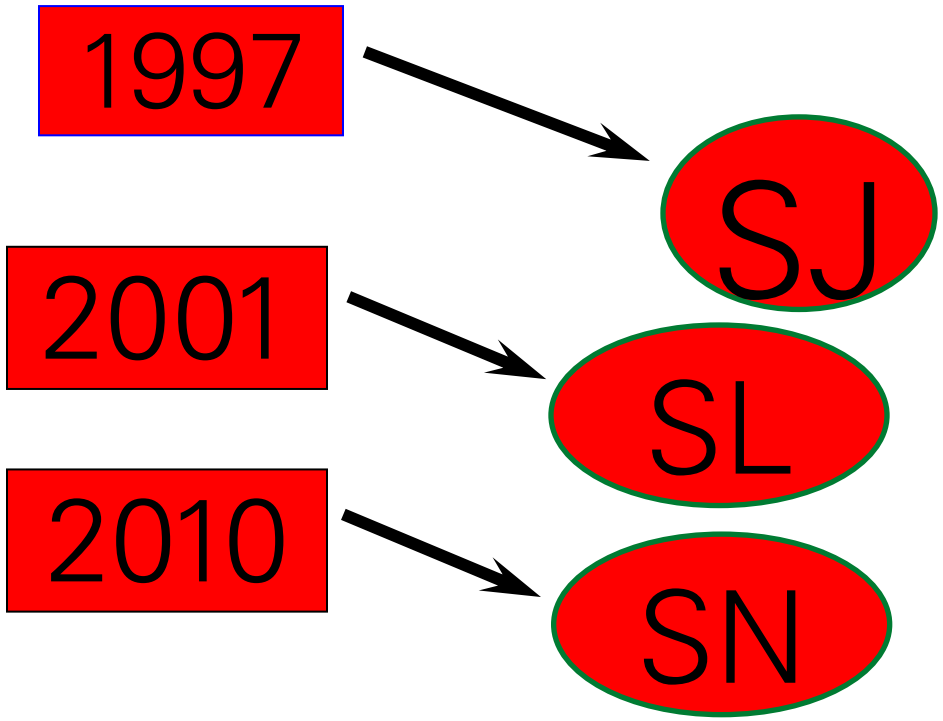
Japanese Automobile Manufacturers Association

AMERICAN PETROLEUM INSTITUTE (API)

API ‘S’ – Service, Gasoline

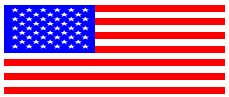


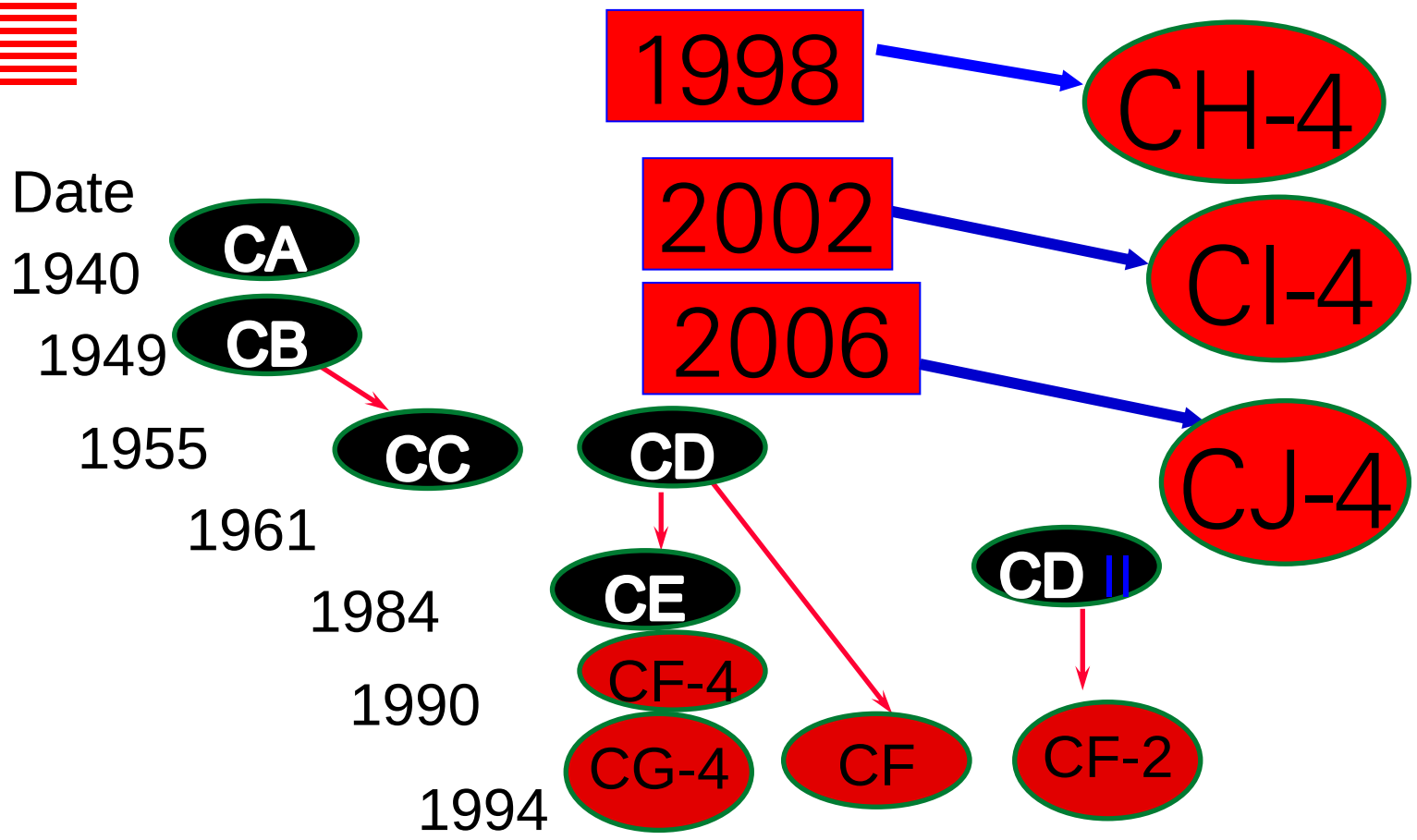
Pre 1930’s	SA
1930	SB
1964	SC
1968	SD
1972	SE
1980	SF
1989	SG
1992	SH



AMERICAN PETROLEUM INSTITUTE (API)

API ‘C’-Service Commercial, diesel





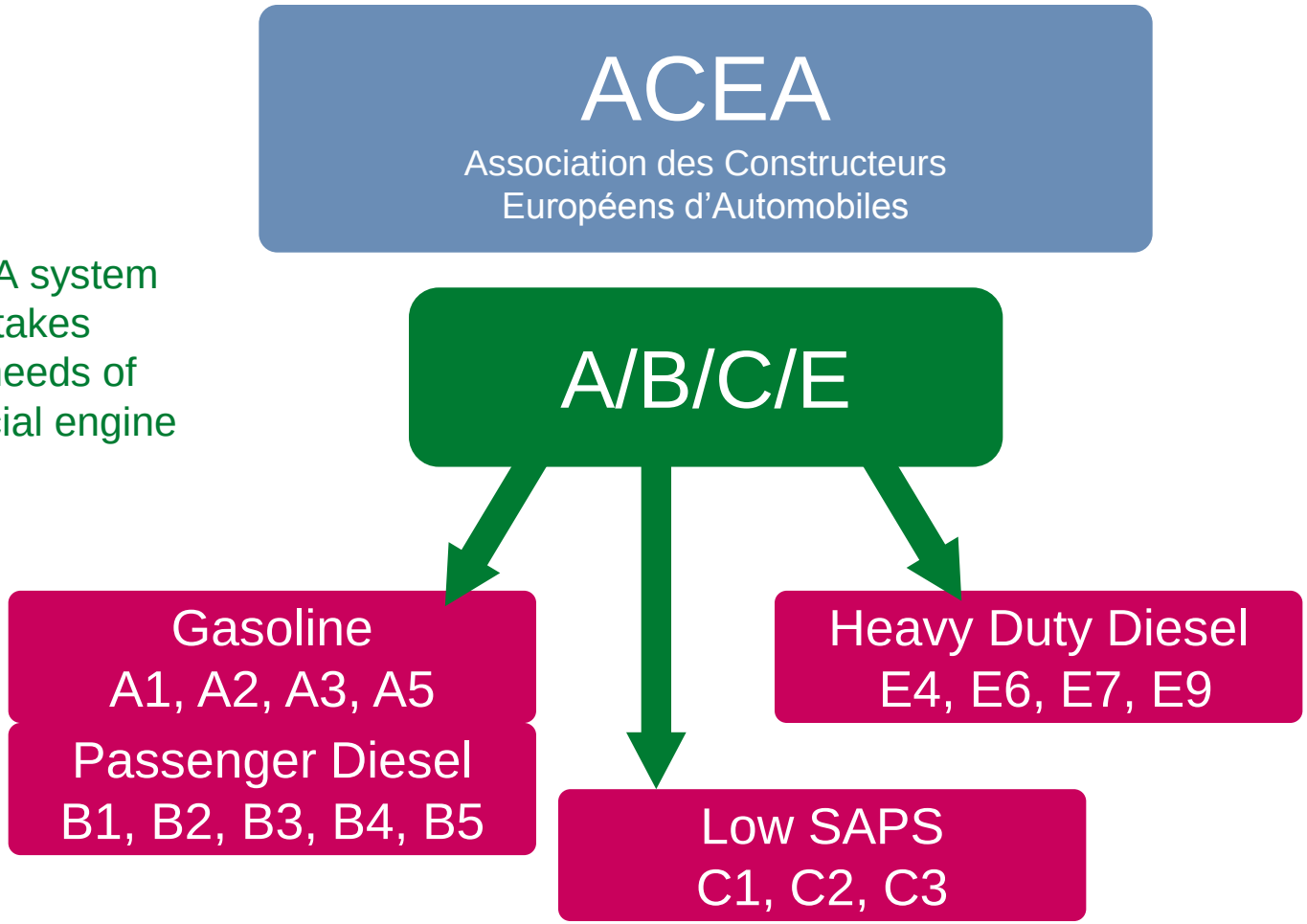
API GEAR OIL SPECIFICATIONS

API (American Petroleum Institute) is the main industry body for gear oil specifications, but there are many different and fragmented driveline specifications.

Type	Description
GL1	Unfortified straight mineral oil
GL2	Worm drive anti-wear mineral oil
GL3	Spiral bevel axles and some manual transmissions

Type	Description
GL-4	Moderate-to-severe conditions of speed and load
GL5	Hypoid shock load, high-speed and torque EP oil. It contains twice as many additives as that at GL4 level.
GL5+	Same as GL5 but with friction modifier for limited slip differential applications

ACEA



The strength of the ACEA system of classification is that it takes account of the different needs of passenger and commercial engine technology

When the ACEA petrol & diesel specs are written they are combined e.g. ACEA A3/B3, A3/B4

ACEA for Engines - Light Vehicles

Fuel Efficiency

A1/B1 Gasoline & diesel cars & light vans Fuel economy Normal drains	A5/B5 High performance gasoline & diesel cars & light vans Fuel economy Extended drains	C2 High performance car & light vans with TWC or DPF Increase TWC and DPF life Fuel economy Mid SAPS oils	C1 High performance car & light vans with TWC or DPF Increase TWC and DPF life Fuel economy Low SAPS oils
A3/B3 High performance gasoline and diesel cars and light vans Extended drain or severe operations	A3/B4 High performance gasoline and direct injection diesel cars and light vans Extended drain or severe operations (OK for A3/B3)	C3 High performance car & light vans with TWC or DPF Increase TWC and DPF life Mid SAPS oils	- Acronym guide - SAPS = Sulphated Ash Phosphorus, sulphur TWC = three way catalyst DPF = Diesel particulate filter

Extended drain

Extended TWC and DPF life

ACEA for Engines – Heavy Duty Vehicles

Soot Handling

E7: Suitable for – Engines without DPF Most engines with EGR Most engines fitted with SCR NOx Reduction System Extended Drain	E6: Suitable for – Engines with EGR Engines fitted with SCR NOx Reduction Systems Strongly recommended for engines fitted with Diesel Particulate Filters in combination with low-sulphur diesel fuel Extended Drain; Low SAPS
E4: Suitable for – Engines without DPF Some engines with EGR Some engines fitted with SCR NOx Reduction Systems Normal Drain	E9: Suitable for – Engines with EGR Engines fitted with SCR NOx Reduction Systems Strongly recommended for engines fitted with advanced exhaust after treatment systems for reduction of particulate matter and nitrogen oxides in combination with low-sulphur diesel fuel. Extended Drain; Low SAPS

Extended drain

Extended DPF life

- Acronym guide -

SAPS = Sulphated Ash Phosphorus, sulphur

EGR = exhaust gas recirculation

DPF = Diesel particulate filter

SCR NOx = Selective Catalytic NOx Reduction systems

WHO SETS SPECIFICATION LEVELS?

OEMs

Cummins

Caterpillar

Hitachi

JCB

Castrol works closely with a number of OEMs to assist in the development of products. **Note – PCO OEM logos**

DRIVELINE SPECIFICATIONS - OEM

OEM and Tier-1 suppliers of driveline parts are developing their own gear oil specifications, the industry is shifting to OEM's/component specifications.

OEM	Manufactures	Specifications
Allison Transmissions	Global leader in automatic transmissions	TES 295 and TES 389.
ZF	Manual and automatic transmissions for vans, trucks and buses	ZF TE-ML 02

Other OEMs developing their own specifications

WHERE TO FIND SPECIFICATIONS AND THE RIGHT PRODUCT?

There are many ways to check a required specification or find a product that meets the specification for your vehicle.

You can consult:

1. The vehicle handbook
2. The Castrol recommendation charts
3. The Castrol online recommendation tool
4. The Castrol technical department
5. OEM dealership

To understand what specifications are covered by Castrol products, you can:

1. Look at the Castrol product brochures
2. Visit the business section of the Castrol website
3. Contact the Castrol technical department.

ON THE NEW MAGNATEC 5 Lt and 1 Lt CONTAINERS

Viscosity Grade and ACEA spec

Back label Vehicle applications and OEM specs

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

HANDBOOK

Minimum OEM requirements

11 Specifications

Fuel, oils, and fluids

11

NOTE

The transmission oil does not normally need to be changed during the service life of the vehicle. However, it may be necessary to replace the oil if the vehicle is often driven in areas of sustained temperature extremes (hot or cold), when towing a trailer over long distances, for prolonged driving in mountainous areas, or if the vehicle is often driven short distances in temperatures under 40 °F (5 °C).

Oil specifications

Engine oil must meet the minimum ILSAC specification GF-4, API SL, or ACEA A1/B1. Lower quality oils may not offer the same fuel economy, engine performance, or engine protection.

Volume: 6.1 US qts (5.8 liters).

Volume between the MIN and MAX marks on the dipstick: approximately 1.4 US qts (1.3 liters).

Volvo recommends Castrol.

Depending on your driving habits, premium or synthetic oils may provide superior fuel economy and engine protection. Consult your Volvo retailer or a trained and qualified Volvo service technician for recommendations on premium or synthetic oils.

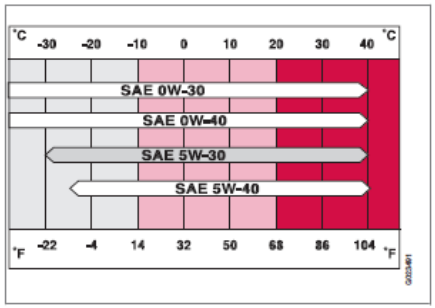
Oil additives must not be used.

NOTE

Synthetic oil is not used when the oil is changed at the normal service intervals. This oil is only used at customer request, at additional charge. Please consult a trained and qualified Volvo service technician.

Oil viscosity

Incorrect viscosity oil can shorten engine life under normal use. SAE 5W-30 will provide good fuel economy and engine protection. See the viscosity chart.

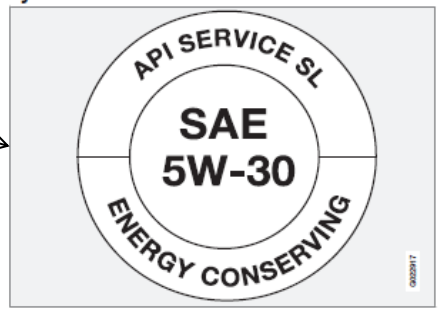


Viscosity chart

Extreme engine operation

Synthetic oils meeting SAE 0W-30 or 0W-40 and complying with oil quality requirements are recommended for driving in areas of sustained temperature extremes (hot or cold), when towing a trailer over long distances, and for prolonged driving in mountainous areas.

American Petroleum Institute (API) symbol



The API Service Symbol "donut" is divided into three parts:

- The upper section describes the oil's performance level.
- The center identifies the oil's viscosity.
- The lower section indicates whether the oil has demonstrated energy-conserving properties in a standard test in comparison to a reference oil.

CASTROL PRODUCT DATA SHEET

Product Data

Castrol Magnatec 5W-30 A5

Instant protection from the moment you turn the key

Description

Up to 75% of engine wear happens while your engine warms up. When the engine stops oil drains off critical engine parts, however Castrol Magnatec's intelligent molecules don't. They cling to the engine like a magnet providing an extra layer of protection.
Castrol Magnatec's unique formulation protects from the moment you turn the key, dramatically reducing* engine wear. Now with ultra-refined molecules, for protection you can see, hear and feel.
Castrol Magnatec. Instant protection from the moment you turn the key.
**As tested in the industry Sequence IVA wear test*

Application

Castrol Magnatec 5W-30 A5 is suitable for use in automotive gasoline and diesel engines where the manufacturer recommends ACEA A5/B5, A1/B1 or API SN/CF ILSAC GF-4 5W-30 Lubricant.
Castrol Magnatec 5W-30 A5 has been developed for use in Ford vehicles that require a 5W-30 lubricant that meetsFord WSS-M2C-913-D, Ford WSS-M2C-913-C, WSS-M2C-913B or WSS-M2C-913A

Advantages

Castrol Magnatec's Intelligent Molecules:
- Cling to critical engine parts when the oil drains down
- Cling to your engine forming an extra layer that protects during start up and beyond;
- Bond to metal surfaces to make engine parts more resistant to wear;
- Are combined with synthetic technology to provide increased protection in high and low temperature applications;
- Provide continuous protection for all driving conditions, styles and temperatures;

Castrol Magnatec 5W-30 A5 delivers superior performance under extreme cold start up conditions relative to thicker grades

Typical Characteristics

Name	Method	Units	Castrol Magnatec 5W-30 A5
Density @ 15C, Relative	ASTM D4052	g/ml	0.84
Viscosity, Kinematic 100C	ASTM D445	mm^2/s	9.6
Viscosity, CCS -30C	ASTM D5293	mPa.s (cP)	4680
Viscosity, Kinematic 40C	ASTM D445	mm^2/s	54
Viscosity Index	ASTM D2270	None	164
Pour Point	ASTM D97	°C	-39
Ash, Sulphated	ASTM D874	% wt	1.24
Flash Point, PMCC	ASTM D93	°C	207

Product Performance Claims

ACEA A1/B1, A5/B5
API SN/CF
ILSAC GF4
Meets Ford WSS-M2C913-A/ WSS-M2C913-B/ WSS-M2C913-C/ WSS-M2C913-D

OEM Specifications

CASTROL PCO RANGE
Brand 1-2-3's

Video clips: CAN YOU FIND THE 1-2-3's?

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

CASTROL GTX RANGE

The Problem

- Poor fuel quality, heat and tough driving conditions can cause to sludge
- Sludge blocks your engine's vital oilways like cholesterol, shortening engine life

The Solution

- Castrol GTX has a Double Action Formula that cleans away old sludge, and protects against new sludge formation

The Benefit

- Helps extend your engine's life

GTX 25W-50

Multigrade SAE 25W50 Mineral Base

API: SG/CF

Basic wear protection for older cars

Superior sludge protection to help extend engine life

Reduces oil consumption

For use in: Petrol engines that require a multigrade API SG/CF - old cars from the 60’s, 70’s and 80’s such as VW Golf, V W Beetle, Mazda 323, Ford Escort

GTX 20W-50

Multigrade SAE 20W-50 Mineral Base

API: SL/CF

Has special anti-sludge formula to give the best sludge protection

Reduces engine wear on startup

Trusted protection for most modern petrol engines

Now formulated with same additives as GTX High Mileage

Can also be used in older cars and those covering long distances

For use in: Petrol engines that require API SL/CF such as: Ford, Mazda, Mitsubishi Tredia, Nissan 1400 Bakkie, Opel, Renault 5, Toyota Corolla

GTX DIESEL 15W-40

Multigrade SAE 15W-40 Mineral Base

API: CI-4/SL

This can be regarded as a multifleet engine oil

Fights soot and other harsh engine deposits

Protects diesel engines against wear

Keeps engine clean inside

Can be used in turbo and non-turbo diesel engines.

For use in:

Diesel and petrol engine cars and bakkies where API CI-4/SL is recommended such as: Toyota Hilux, Isuzu KB, Tata, Ford Courier, GWM, Hyundai, Daihatsu

GTX ULTRACLEAN 10W-40

Multigrade SAE 10W-40 Part synthetic

API: SN/CF

ACEA A3/B3, A3/B4

Unique Double Action formula cleans away old sludge, and protects against new sludge formation.

Help extend the life of your engine.

Include - Different 123’s

For use in:

Out of warranty cars that require API SN/CF or ACEA A3/B3, A3/B4 such as: Toyota, Nissan, Renault, Kia, Hyundai

CASTROL MAGNATEC RANGE

The Problem

- Up to 75% of engine wear happens during warm up

The Solution

- Castrol Magnatec has Intelligent molecules that cling to engine even when it is standing overnight

The Benefit

- Engine wear is dramatically reduced

MAGNATEC10W-40

Multigrade SAE 10W-40 Part-Synthetic

API: SN/CF

ACEA: A3/B3, A3/B4

OEM: Fiat 9.55535-D2, MB- 226.5/ 229.1, Renault RN 0700 / RN 0710, VW 502 00 / 505 00

Instant protection from the moment you turn the key

Maximum protection for daily start stop town driving

Intelligent molecules cling to engine even when it is standing overnight

Bonds to engine parts to prevent wear

For use in: Modern petrol engines that require API SL/CF such as: Nissan, Renault, Alfa, Citroen, Fiat, Peugeot, Toyota Yaris, Volvo

MAGNATEC 5W-40 A3/B4

Multigrade SAE 5W-40 Full Synthetic

API: SN/CF

ACEA: A3/B4, A3/B3

BMW Longlife-01, MB-Approval 226.5/ 229.3, Renault RN 0700 / RN 0710, VW 502 00 / 505 00

Instant protection from the moment you turn the key

Maximum protection for daily start stop town driving

Intelligent molecules cling to engine even when it is standing overnight

Bonds to engine parts to prevent wear

For use in: Modern petrol engines that require API SN/CF such as: BMW, Nissan, Renault, Chrysler, Citroen, Fiat, Peugeot, Toyota, Volvo

MAGNATEC 5W40 C3

Multigrade SAE 5W40 Full Synthetic

API: SN/CF

ACEA: C3

BMW Longlife-04, GM dexos2®*, Meets Fiat 9.55535-S2, MB-Approval 226.5/ 229.31, Renault RN 0700 / RN 0710, VW 502 00/ 505 00

Instant protection from the moment you turn the key

Maximum protection for daily start stop town driving

Intelligent molecules cling to engine even when it is standing overnight

Bonds to engine parts to prevent wear

For use in: Modern petrol engines that require API SN/CF such as: BMW, V W, Fiat, Peugeot, Seat, Opel, Honda, Mercedes Benz, Renault

MAGNATEC 5W-30 A5

Multigrade SAE 5W-30 Full Synthetic

API: SN/CF

ACEA: A1/B1, A5/B5

ILSAC GF4, Meets Ford WSS-M2C913-A/ WSS-M2C913-B/ WSS-M2C913-C/ WSS-M2C913-D

Instant protection from the moment you turn the key

Maximum protection for daily start stop town driving

Intelligent molecules cling to engine even when it is standing overnight

Bonds to engine parts to prevent wear

For use in: Modern petrol engines that require API SN/CF such as: Ford, Volvo, Toyota, Honda, Mazda, Jaguar, Land Rover, Mitsubishi

CASTROL EDGE

The Problem

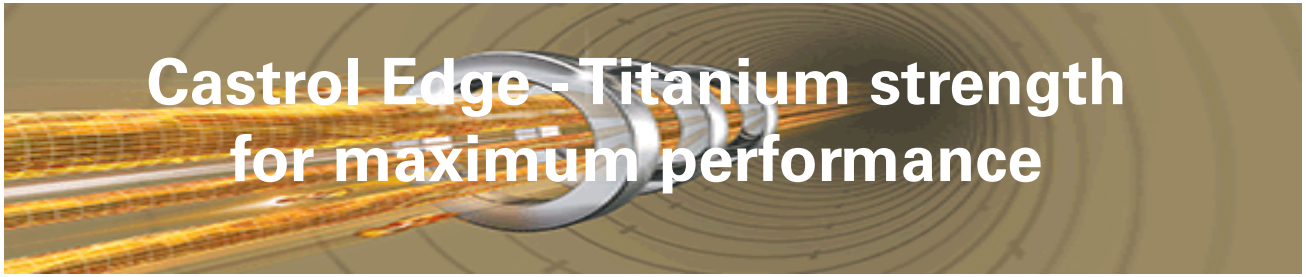
- Today's engines are more efficient and more powerful. This has led to the doubling of pressure in the engine.
- The only thing keeping metal engine components apart is the oil, so it needs to be strong and remain strong.

The Solution

- Castrol EDGE boosted with TITANIUM FST doubles its film strength, preventing oil film breakdown and reducing friction

The Benefit

- Confidence to demand maximum engine performance



EDGE 5W40

Multigrade SAE 5W40 Fully Synthetic

API: SN/CF

ACEA: C3

OEM: BMW Longlife-04, dexos2®*, Fiat 9.55535-S2, Ford WSS-M2C917-A MB- 226.5/ 229.31/ 229.51, Renault RN 0700 / RN 0710, VW 502 00 / 505 00/ 505.01

Castrol's Best Performance

Boosted with TITANIUM FST™ - Strength for Maximum Performance

Best protection even when running hard and hot

Turbo-proven under pressure

For use in: Latest model petrol and diesel engines that require API SN/CF such as: Mercedes, BMW, Jeep, V W, Audi, Chrysler, Jaguar, Kia Sportage, Volvo

EDGE 10W-60 SN

Multigrade SAE 10W60 Fully Synthetic

API: SN/CF

ACEA: A3/B3, A3/B4

Castrol's Best Performance

Boosted with TITANIUM FST™ - Strength for Maximum Performance

Best protection even when running hard and hot

Turbo-proven under pressure

For use in: High performance sports cars

EDGE SUPERCAR 10W-60

Multigrade SAE 10W60 Fully Synthetic

API: SN/CF

ACEA: A3/B3, A3/B4

OEM Approvals: BMW M-Models; Koenigsegg Approved VW 501 01/ 505 00 specifying 10W-60

Castrol's Best Performance

Boosted with TITANIUM FST™ - Strength for Maximum Performance

Doubles its film strength, preventing oil film breakdown and reducing friction

Best protection even when running hard and hot

Turbo-proven under pressure

For use in: BMW M-Models, V W, Aston Martin V8 Vantage S, Audi R8 V10 GT, Bugatti Chiron, Bugatti Veyron, Ferrari F12 Berlinetta and Ferrari FF

CASTROL COMMERCIAL VEHICLE OILS

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol

CASTROL COMMERCIAL VEHICLE OILS

- VECTON 15W-40
- VECTON LONG DRAIN 10W-40
- VECTON LONG DRAIN 10W-40 E6/ E9
- TECTION 15W-40
- J-MAX PLUS 15W-40

CASTROL VECTON

01

THE INSIGHT

My ambition to succeed in business drives me to get the best from my vehicles, but their performance varies with changing engine conditions.

02

THE REASON TO BELIEVE

System5 Technology™ adapts to changing conditions and improves engine performance in 5 critical areas:
a) Fuel consumption b) Oil consumption
c) Oil change interval d) Power e) Component life

03

THE UNIQUE SELLING PROPOSITION

Castrol Vecton with unique System 5 Technology™, adapts to changing engine condition and helps maximise engine performance.

CASTROL VECTON 15W-40

Vecton 15W-40 is an advanced engine oil, formulated with unique System 5 Technology™ for up to 40% better performance.*

Applications

- Vecton 15W-40 is suitable for a wide range of European and US diesel engines, in on- and off-highway applications.

Features and Benefits

Castrol Vecton 15W-40's unique System 5 Technology™ adapts to changing engine conditions to help maximise performance in 5 key areas:

1. **Fights oil thickening** to give better fuel efficiency
2. **Fights piston deposits** to give lower oil consumption
3. **Fights contaminants** to give longer oil drain intervals
4. **Fights wear and corrosion** to enhance the life of critical engine components
5. **Fights soot** to improve engine power all the way through the oil drain

Specifications: ACEA E7, API CI-4/SL, MB-Approval 228.3, MAN M 3275-1, GLOBAL DHD-1, Renault RLD-2, Volvo VDS-3, Cummins CES 20076, CES 20077, CES 20078, Cat ECF-2, Mack EO-M Plus, EO-N

*In independent laboratory tests, Castrol Vecton 15W-40 performed up to 40% better than API and ACEA industry standard limits across oil thickening, piston deposits, soot handling and wear and corrosion.

VECTON LONG DRAIN 10W-40 E7

New Vecton Long Drain 10W-40 E6/ E9 is a full synthetic engine oil for extended drain in modern European diesel engines. It is formulated with unique System 5 Technology™ for up to 40% better performance*.

Applications

- Extended drain in modern diesel engines, including Euro 4*, Euro 3 and Euro 2 European trucks and buses
- Also for off-road vehicles and equipment
- *Not for use in Euro 4 vehicles requiring low SAPS lubricants. For this application we recommend Castrol Vecton Long Drain 10W-40 E6/ E9

Features and Benefits

Castrol Vecton Long Drain 10W-40 E7's unique System 5 Technology™ adapts to changing engine conditions to help maximise performance. Even when you run extended drains under severe operating condition, System 5 Technology™ helps to:

- **Fight harmful acids** which form during engine operation, maintaining TBN reserve throughout the oil drain
- **Fight wear** to critical engine components
- **Fight piston deposits** even under severe operating conditions.

Specifications: ACEA E4/E7, API CF, MB-Approval 228.5, MAN M 3277, Volvo VDS-3, Renault RLD-2, MTU Oil Category 3, Deutz DQC III-10, Mack EO-N, meets DAF requirements.

VECTON LONG DRAIN 10W-40 E6/ E9

Castrol Vecton Long Drain 10W-40 E6/E9 is a full synthetic low SAPS engine oil formulated with unique System 5 TechnologyTM for up to 40% better performance1.

Applications

- Extended drain in modern diesel engines, designed for extended drain in the latest Euro 6 diesel engines.
- Off-road vehicles and equipment
- Also for low emission Euro 4 & Euro 5 European trucks and buses, especially those requiring a low SAPS lubricant

Features and Benefits

Castrol Vecton Long Drain 10W-40 E7's unique System 5 Technology™ adapts to changing engine conditions to help maximise performance. Provides exceptional resistance to contaminants, and delivers outstanding performance even when you run extended drains under severe operating condition, System 5 Technology™ helps to:

- **Fight harmful acids** which form during engine operation, maintaining TBN reserve throughout the oil drain
- **Fight wear** to critical engine components
- **Fight piston deposits** even under severe operating conditions.

Specifications: ACEA E6, E7, E9, API CJ-4, JASO DH-2, CAT ECF-3, Cummins CES 20.081, Deutz DQC IV-10LA, Mack EO-O Premium Plus, MAN M 3271-1, M 3477, MB-Approval 228.51, MTU Oil Category 3.1, RVI RLD-3, Volvo CNG, VDS 4, For Iveco trucks requiring ACEA E6/E7/E9, Meets DAF requirements

PRODUCT ONLY IN 210 LT DRUMS

CASTROL DRIVELINE LUBRICANTS

Transmission System

Gear Oils

ABOUT GEARS

GEARS ARE USED FOR:

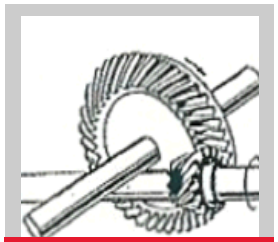
- DIFFERENT SPEEDS FOR DIFFERENT DRIVING CONDITIONS
- PROVIDE POWER DEPENDING ON LOAD & ROAD CONDITIONS
- TRANSMISSION SYSTEMS PROVIDE THIS VARIATION OF SPEED & POWER


Helical gear


Worm gear


Spur gear


Bevel gear


Hypoid Gear


Double Helical Gear

API GEAR OIL SPECIFICATIONS

API (American Petroleum Institute) is the main industry body for gear oil specifications, but there are many different and fragmented driveline specifications.

Type	Description
GL1	Unfortified straight mineral oil
GL2	Worm drive anti-wear mineral oil
GL3	Spiral bevel axles and some manual transmissions

Type	Description
GL-4	Moderate-to-severe conditions of speed and load
GL5	Hypoid shock load, high-speed and torque EP oil. It contains twice as many additives as that at GL4 level.
GL5+	Same as GL5 but with friction modifier for limited slip differential applications

VERY IMPORTANT:

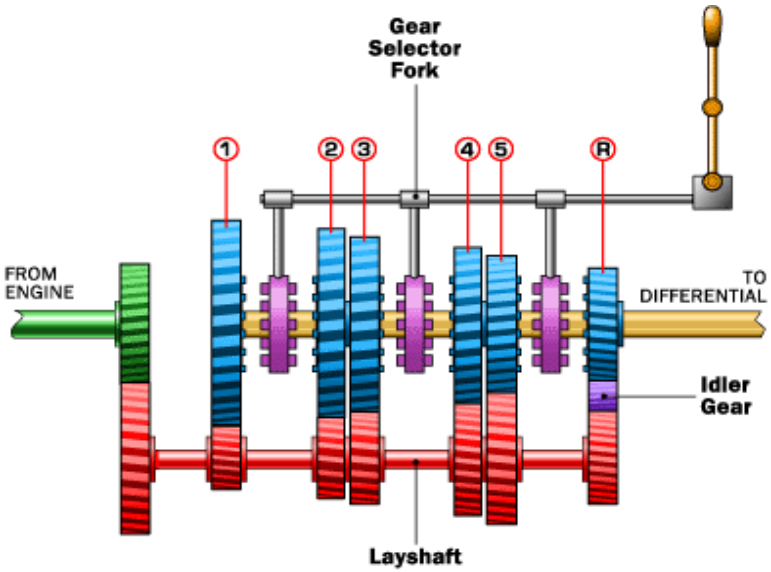
GL-4 ONLY FOR MANUAL GEARBOXES

GL-5 ONLY FOR DIFFERENTIALS

MANUAL TRANSMISSION SYSTEMS

Manual Transmission

- Main shaft and lay shafts
- Gears have external teeth & locking rings have internal teeth. The external teeth on the gear engage with internal teeth on the locking ring to rotate the main shaft
- Gears on the output shaft are free to rotate but the locking rings are fixed to the output shaft
- The power passes from engine to the gears on the lay shaft & these gears transmit power to gears on the output shaft helping to move the vehicle.
- As the driver shifts the gear stick, one of the locking rings engages with a gear & the output shaft starts rotating



MANUAL TRANSMISSION OILS

Features	Why is it required?
Reduces Friction	This reduces heat generation and formation of wear particles.
Corrosion Protection	Reduce wear and prevent corrosion
Dissipate heat	They have a high capacity to transfer heat
Demulsify water from oil	They separate water from oil. This helps control the moisture level.
Protect against gear teeth pitting	Pits are the result of surface cracks caused by metal-to-metal contact of the working components or defects due to low lubrication.
Reduce effects of shock loading	They protect components from the sudden and intense force placed on them due to the transmission working.

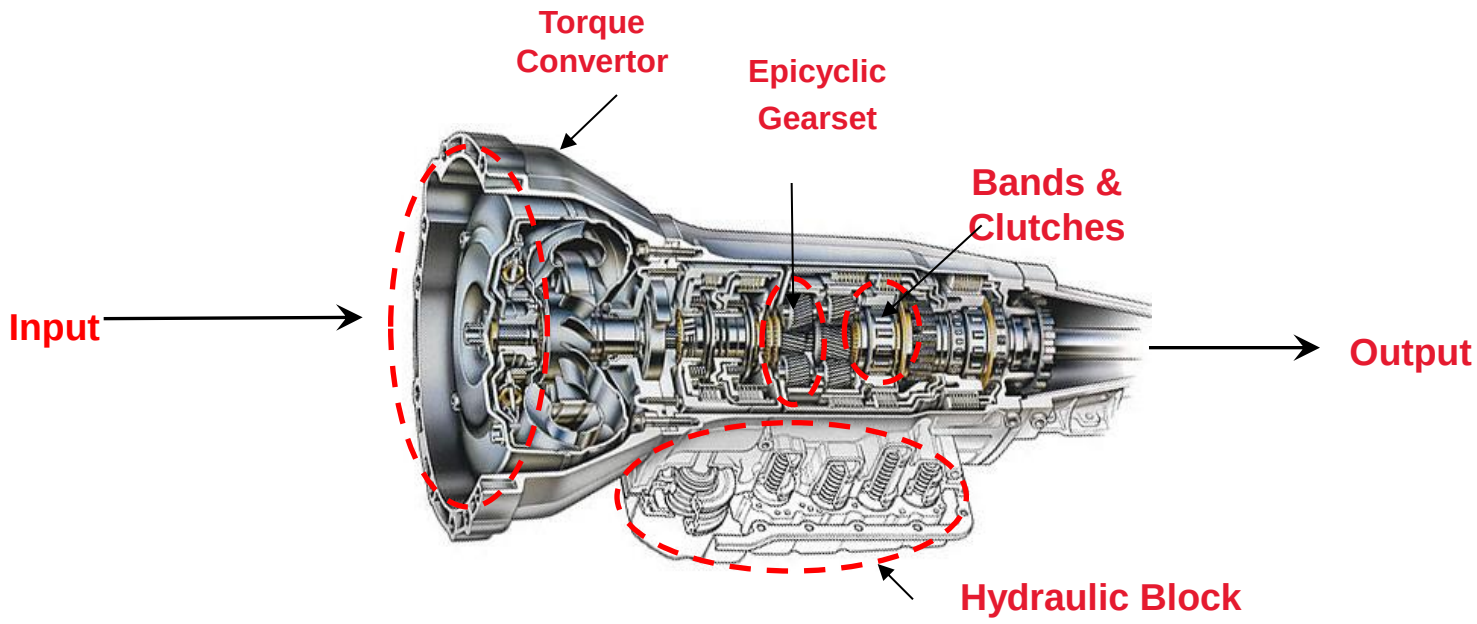
MANUAL TRANSMISSION OILS

Castrol Manual Transmission Fluids				
Product	**Base Oil**	**Application**	**Specifications**	**Benefits**
Manual EP 80W	Mineral	**Manual transmission fluid** for use where API GL-4 is required Used in passenger cars, LCVs and trucks, approved for many MB and ZF transmissions	SAE 80W API GL-4 ZF TE-ML 02A, 17A MAN 341 type Z1 MB-Approval 235.1	✓Wide range of European OEM approvals ✓High thermal stability maintains the life and performance of lubricant and transmission ✓Good antiwear and load carrying characteristics extend component life
Manual GL-4 80W-90	Mineral	**Manual transmission fluid** for API GL-4 applications.	API GL-4	✓Good antiwear and load carrying characteristics extend component life ✓Improved low temperature protection and gear shifts compared to monograde products
Manual VMX 80W	Mineral	**API GL-4 Manual transmission** fluid. For transmissions of most car or LCV's. Can be used as low drag gearbox oil in 2 stroke motorcycles with separate gearboxes	API GL-4	✓Quieter transmission operation easier gear changes over a wide temperature range ✓Improved gear tooth and bearing durability extend component life and reduce risk of breakdown
BOT 402 (SAE 75W-85)	Synthetic	**Full synthetic SAE 75W-85 manual transmission.** Approved for Opel & GM manual transmissions.	API GL-4 Opel specification B 040 2071	✓Reduces torque loss & increases efficiency over all transmission load ranges ✓Fuel saving potential which means lower emissions ✓Extended synchroniser life reduces warranty and maintenance costs
Syntrans Multivehicle 75W-90	Synthetic	**Fully synthetic SAE 75W-90 manual transmission fluid.** Approved by Ford & Mercedes Has solved low temperature shiftability issues in numerous transmissions	SAE 75W-90 API GL-4 Ford WSD-M2C200-C MB-Approval 235.72	✓Excellent synchroniser performance gives extended synchroniser life and shift comfort ✓Exceptional cold flow properties improve low temperature shiftability ✓Temperature reduction in operation improves lubricant life and fuel efficiency

TRANSMISSION SYSTEMS

Automatic Transmission

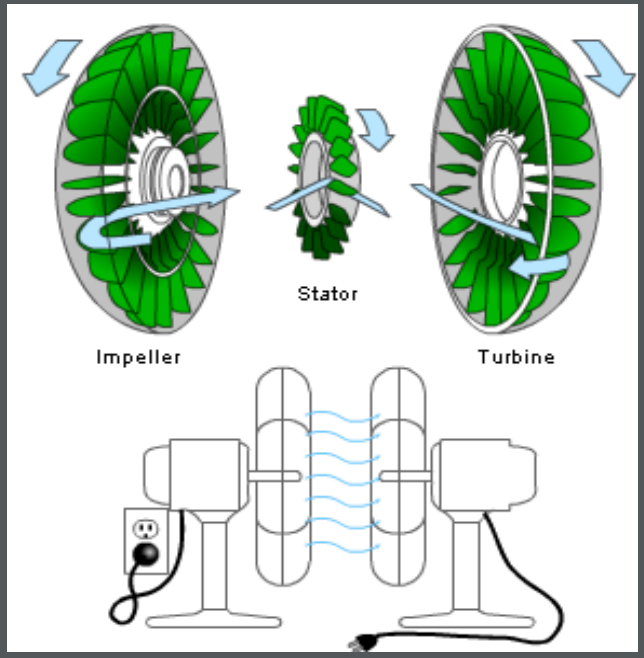
An **automatic transmission** is an **automobile gearbox** that can change **gear ratios** automatically as the vehicle moves, freeing the driver from having to shift **gears** manually. The *AT* will select the **optimal gear** for the driving conditions and aims to provide a smoother ride."



AUTOMATIC TRANSMISSION SYSTEM

Torque Converter

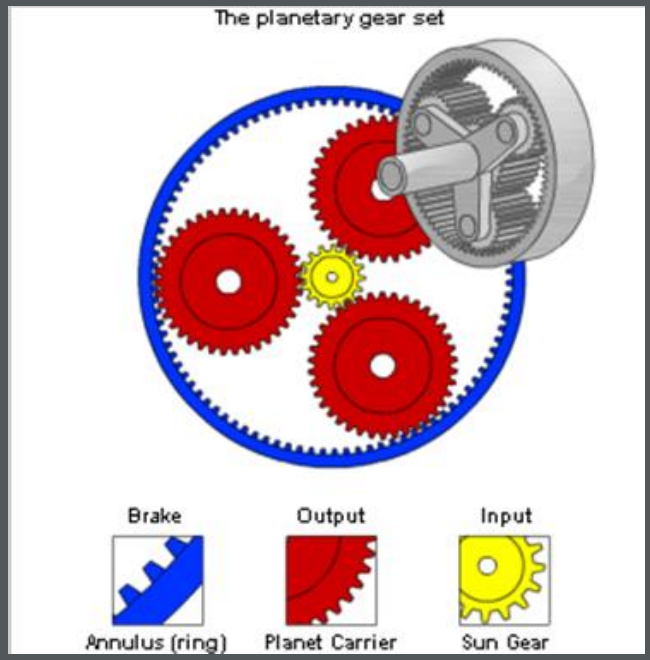
1



Connects and disconnects the engine from the transmission

Epicyclic / Planetary Gear set

2

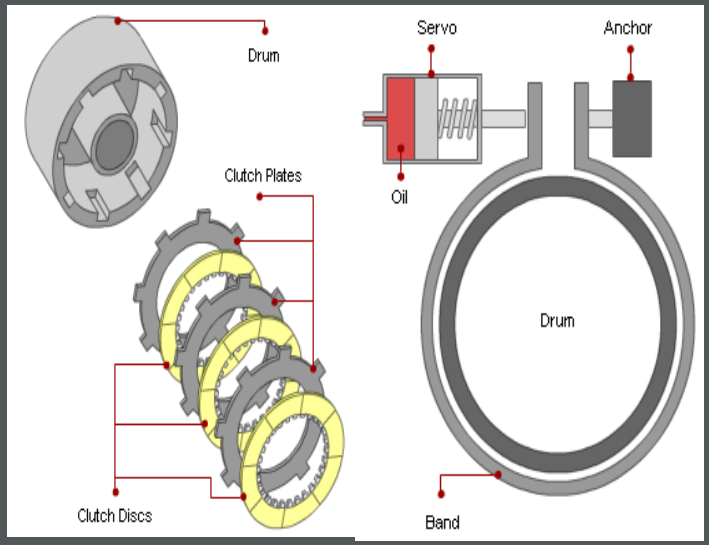


Provides multiple gear ratios

AUTOMATIC TRANSMISSION SYSTEM

Clutches & Bands

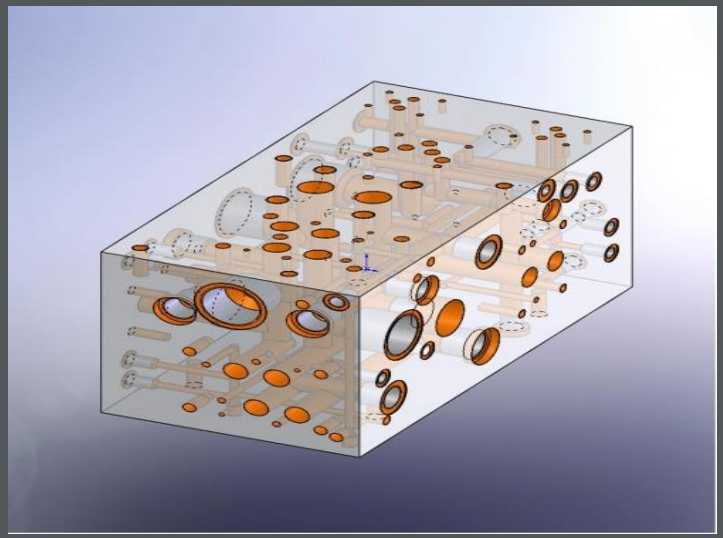
3



Clutches transmit power to gear set and Bands restrains part of the gear set

Hydraulic valve block

4



Brain of the system, manages the shifting of gears depending on the vehicle speed, engine speed and driver input

AUTOMATIC TRANSMISSION SYSTEM

Features	Why is it required?
Reduces Friction	This reduces heat generation and formation of wear particles.
Low Temperature Fluidity	For effective operation of hydraulics & electronic controls
Dissipate heat	They have a high capacity to transfer heat
High Viscosity Index	To maintain viscosity across a wide temperature change
Thermal & Oxidative stability	To prevent sludge & deposits that get generated due to high heat
Reduce effects of shock loading	They protect components from the sudden and intense force placed on them due to the transmission working.
Foam suppression	Reduces accelerated gear wear and overheating caused by foaming

AUTOMATIC TRANSMISSION FLUIDS

Castrol Automatic Transmission Fluids				
Product	**Base Oil**	**Application**	**Specifications**	**Benefits**
ATF Dex II Multivehicle	Mineral	**Automatic Transmission Fluid** for automatic transmissions and power steering units. For use in vehicles requiring Dexron II or Mercon	GM Dexron® IID Meets Ford Mercon® MAN 339 type Z1, V1 ZF TE-ML 03D, 04D, 11A, 14A, 17C MB-Approval 236.6 Voith H55.6335xx Bosch Rexroth RD 90 220-1 / 08.6	✓Multiple approvals provide wide ranging use ✓Ensures efficient operation of power steering units under all conditions ✓High thermal stability protects against deposits and oil thickening prolonging the part & lubricant life
Transmax Dex III Multivehicle	Part Synthetic	**Part synthetic automatic transmission fluid** designed for GM & Ford automatic transmissions requiring Dexron (II or III) or Mercon	Allison C4 and TES 389 Ford Mercon® GM Dexron® IIIH MAN 339 type Z1, V1 ZF TE-ML 04D, 14A, 17C MB-Approval 236.9 Voith H55.6335xx Volvo 97340 and 97341	✓Optimised friction characteristics provide smooth shifting and efficient power transfer ✓High viscosity index provides a stable viscosity over a wide temperature range for effective protection of transmissions and operation of power steering units
Transmax Dex VI Mer LV	Full Synthetic	**Technologically advanced OEM approved Automatic Transmission Fluid** licensed by Ford (MERCON® LV) and GM (DEXRON®-VI) Exceeds requirements of the JASO-1A performance standard created by Japanese automobile manufacturers	Ford Mercon® LV; GM Dexron® VI; JASO 1A, JASO 1A LV; Toyota T, T II, T III, T IV, WS; Nissan Nissan Matic D, J, S Mitsubishi SP II,IIM, III, PA, J3, SP IV; Mazda ATF M-III, M-V, JWS 3317, FZ; Subaru F6, Red 1; Daihatsu AMMIX ATF D-III Multi, D3-SP; Suzuki AT Oil 5D06, 2384K, JWS 3314, JWS 3317; Hyundai/Kia SP III, SP IV; Aisin Transmissions requiring JWS 3309; Honda/Acura DW 1/Z 1; Isuzu (where Toyota T-IV is required)	✓Multiple approvals provide wide ranging use ✓Ensures efficient operation of power steering units under all conditions ✓High thermal stability protects against deposits and oil thickening prolonging the part & lubricant life

AUTOMATIC TRANSMISSION FLUIDS

Castrol Automatic Transmission Fluids				
Product	**Base Oil**	**Application**	**Specifications**	**Benefits**
Transmax Z	Full Synthetic	**Full synthetic transmission fluid** Particularly suited for automatic and semi automatic transmissions used in buses and coaches	VW 501 60 MAN 339 type Z3, Z12, V2 ZF TE-ML 04D, 11B, 14C, 16M, 20C MB-Approval 236.81 Voith H55.6336xx	✓Enhanced protection against deposits extends transmission life ✓Temperature reduction in severe service improves service life and helps reduce fuel consumption and emissions ✓Optimised frictional characteristics providing smoother gear changes
Transynd	Full Synthetic	Recommended for **Allison, Mercedes Benz and ZF** automatic transmissions fitted to off-road & commercial vehicles	Allison TES 295, TES 468 MB-Approval 236.91; 238.22 ZF TE-ML 04D, 14C, 16M, 20C Voith H55.6336.xx	✓Optimised and stable friction characteristics for effective operation of limited slip differentials ✓Very good wear protection, even under severe conditions, prolongs component life

DIFFERENTIALS

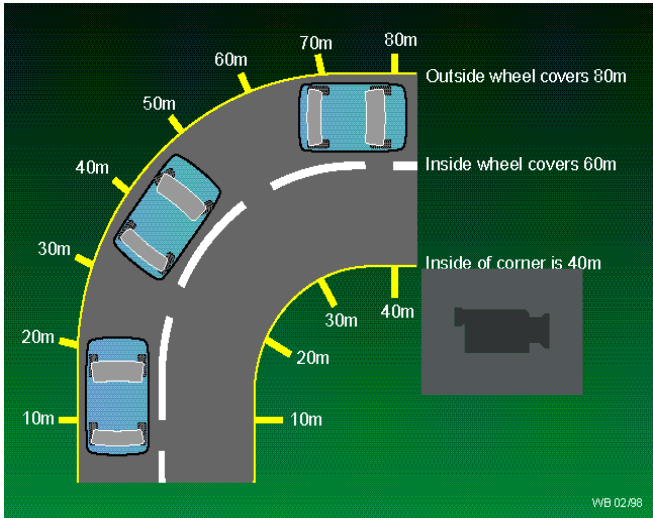
Most axles are combined with a differential and have three main functions

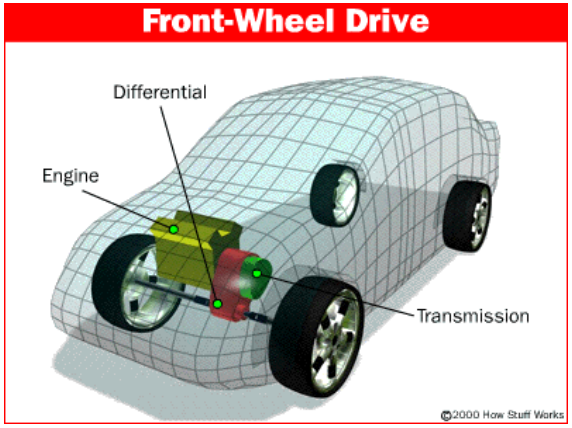
Why? - Vehicle wheels spin at different speeds, especially when turning.

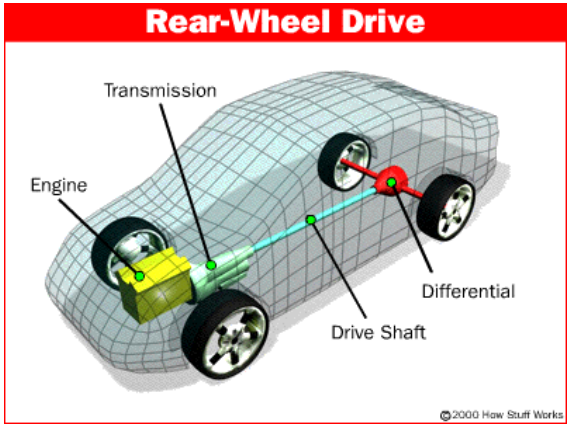
What? - Splits engine torque two ways, allowing each wheel to spin at a different speed.

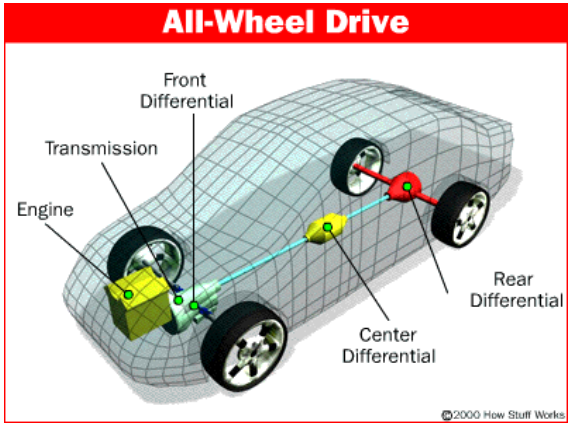
3 Functions:

- Deliver engine power / transmission power to the wheels
- Provide final gear reduction, reducing rotational speed of engine / transmission before it hits wheels
- Permit wheels to rotate at different speeds → “differential”







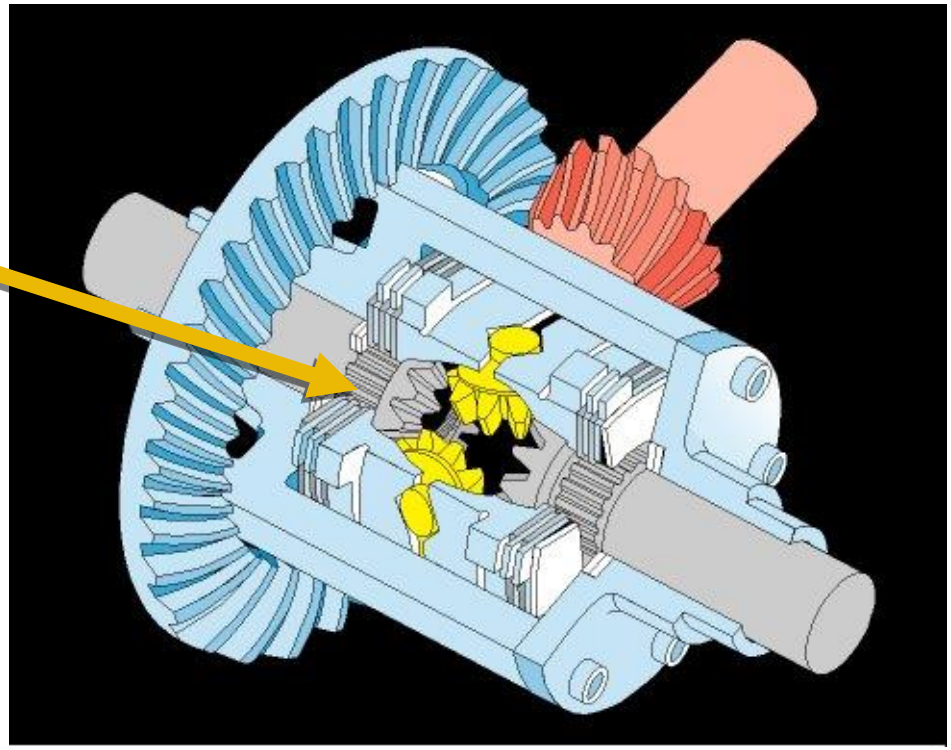


LIMITED SLIP DIFFERENTIALS

Limited slip differentials prevent all power being transferred to one wheel when that wheel is on a slippery surface e.g. ice or mud

Clutches apply friction to the shaft of the spinning road wheel

This diverts rotational power to the opposite shaft, allowing the vehicle to gain traction and move off.



REAR AXLES HYPOID GEARS

Used in RWD applications

- Drive needs to be transmitted through 90°
- Replace bevel gears in modern vehicles – curved teeth
- Rotation axis offset

Lubricant Impact

- Continuous sliding motion

DIFFERENTIAL OILS

Castrol Mineral Differential Oils				
Product	**Base Oil**	**Application**	**Specifications**	**Benefits**
Axle EPX 80W-90	Mineral	**Differentials and final drives** in passenger cars and commercial requiring API GL-5 performance approved for ZF final drives	API GL-5 ZF TE-ML 16B, 17B, 19B, 21A	✓High load carrying capability ensures gear protection prolonging component life ✓Good film strength protects against wear and shock loads
Axle EPX 85W-140	Mineral	**Differentials and final drives** in passenger and commercial vehicles Approved by ZF for commercial, off-road and agricultural applications	API GL-5 Approved - ZF TE-ML 05A, 12E, 16D, 21A MAN 342 Typ M1	✓High load carrying capability ensures gear protection prolonging component life ✓Good film strength protects against wear and shock loads
Axle EPX 90	Mineral	**Multipurpose axle oil** approved for ZF, MAN & Mercedes final drives	API GL-5 ZF TE-ML 16C, 17B, 19B, 21A MAN 342 M1 MB-Approval 235.0	✓Wide range of European OEM approvals ✓High thermal stability maintains the life and performance of lubricant and transmission ✓Good antiwear and load carrying characteristics extend component life
Axle Z Limited Slip 90	Mineral	**limited slip differentials in** cars and commercial vehicles Approved by ZF for use in their multi-disc wet brakes and self-locking differentials	API GL-5 ZF TE-ML 05C, 12C, 21C	✓Optimised and stable friction characteristics for effective operation of limited slip differentials ✓Very good wear protection, even under severe conditions, prolongs component life

DIFFERENTIAL OILS

Castrol Synthetic Differential Oils				
Product	**Base Oil**	**Application**	**Specifications**	**Benefits**
Syntrax Long Life 75W-90	Synthetic	**Full synthetic multigrade final drive lubricant** Castrol's prime recommendation for final drives in heavy commercial vehicles	API GL-5 ZF TE-ML 05B, 12B, 17B, 19C, 21B MAN 342 type S1 Scania STO 1.0 BMW (non limited slip rear axles)	✓Fuel savings and reduced emissions ✓Superior low temperature and fluidity pumpability ensures protection at start up under all conditions ✓Excellent thermal and oxidative stability provides final drive and differential cleanliness which permits extended drain and decreased servicing
Syntrax Limited Slip 75W-140	Synthetic	**Synthetic hypoid gear oil** formulated for use in both conventional and limited slip differentials	API GL-5 ZF TE-ML 05D, 12D, 16G, 21D BMW LS Rear Axles MB-Approval 235.61 Recommended for use in Nissan GTR Ltd Slip Axles	✓Reduces noise and vibrations in the axle ✓Exceptional stability at high temperatures extending the life of lubricant and axle ✓Effective wear resistance ensures protection under high loads and prevents damage to components

CASTROL ANCILLARIES

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol

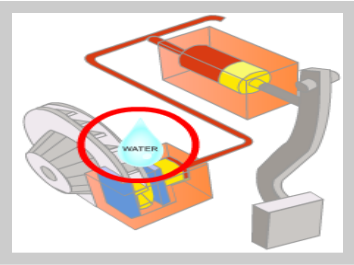
CASTROL BRAKE FLUID

Braking System

Brake Fluids

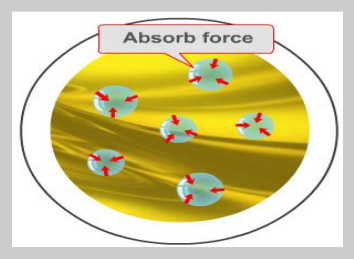
WORKING OF A BRAKE SYSTEM

A BRAKE FLUID IS A HYDRAULIC FLUID THAT DOES THE JOB OF TRANSMITTING POWER FROM THE BRAKE PEDAL TO THE BRAKE COMPONENTS.

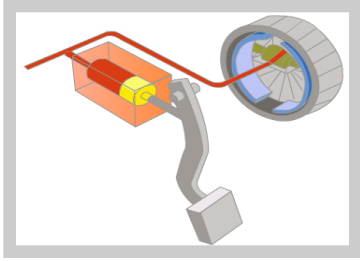


Moisture is the biggest enemy of a braking system.

- Vaporises
- Forms vapour bubbles in the brake fluid



These vapour bubbles get compressed and absorb the force, and hence the full force is not transferred properly to the braking system.



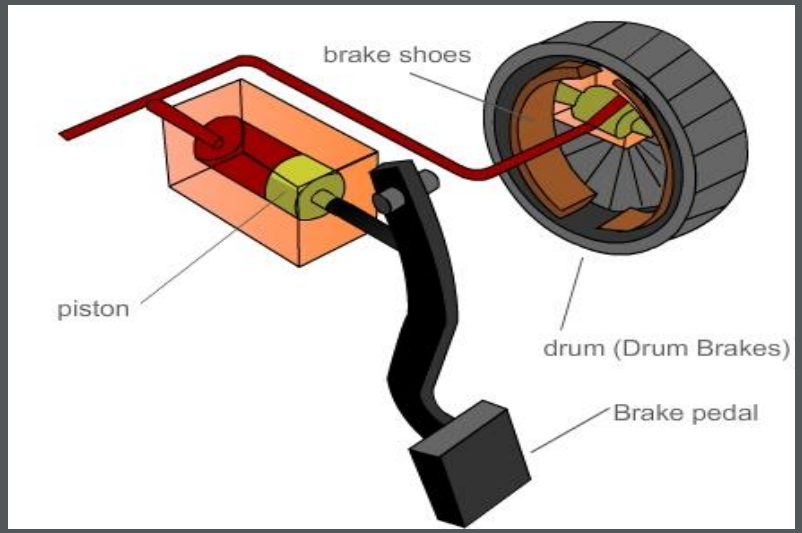
Causes Vapour Lock and at this point brake failure will occur.

Thus, to transfer the power to the brake components efficiently, the brake fluid must be incompressible.

NB!! SAFETY CRITICAL BRAKE FLUID IS HYGROSCOPIC – IT ABSORBS WATER FROM THE ATMOSPHERE THIS MEANS USE THE ENTIRE CONTENTS IN THE BOTTLE OR SAFELY DISCARD ANY LEFT OVER BRAKE FLUID

TYPES OF BRAKE SYSTEM

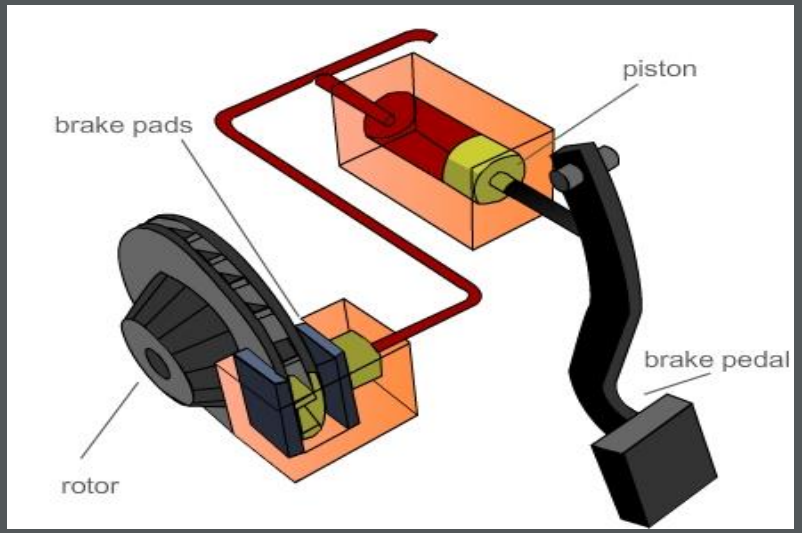
Drum Braking System



- A driver presses the pedal
- A wheel cylinder piston pushes the brake shoes against a revolving drum fitted to the wheel.
- The friction between brake shoes and drum stops the revolving drum and the wheel. Thus, the vehicle stops.

Generally, drum brakes are **installed on rear wheels.**

Disc Braking System



- A driver presses the brake pedal
- A wheel cylinder piston pushes the brake pads, which clamps the brake disc. This disc is attached to a wheel hub.
- The friction between brake pads and the disc stops the brake disc and the wheel. Thus, the vehicle stops.

Generally, disc brakes are **installed on front wheels**.

BRAKING SYSTEM

Features	Why is it required?
High boiling point, at least 220°C	To avoid vaporizing in the lines
High vapour-lock temperature	To provide protection
Low evaporation loss	Minimises vapour formation, which in turn can reduce the brake efficiency
Excellent protection against corrosion	To protect metal components such as callipers, master cylinders etc.
High temperature stability	To function effectively under extreme braking conditions
Optimum operating viscosity	To help maintain the right viscosity even at high temperatures
Rubber swell control	To maintain the swell characteristics of seals in the hydraulic system

CASTROL COOLANTS

Cooling System

Coolants

COOLANT REQUIREMENT

ENGINES BURN FUEL TO GENERATE POWER. THIS GENERATES A LARGE AMOUNT OF HEAT.

Modern engines

- Are more compact
- Operate at higher RPM
- Deliver increased output
- Have less cooling air travelling through them.

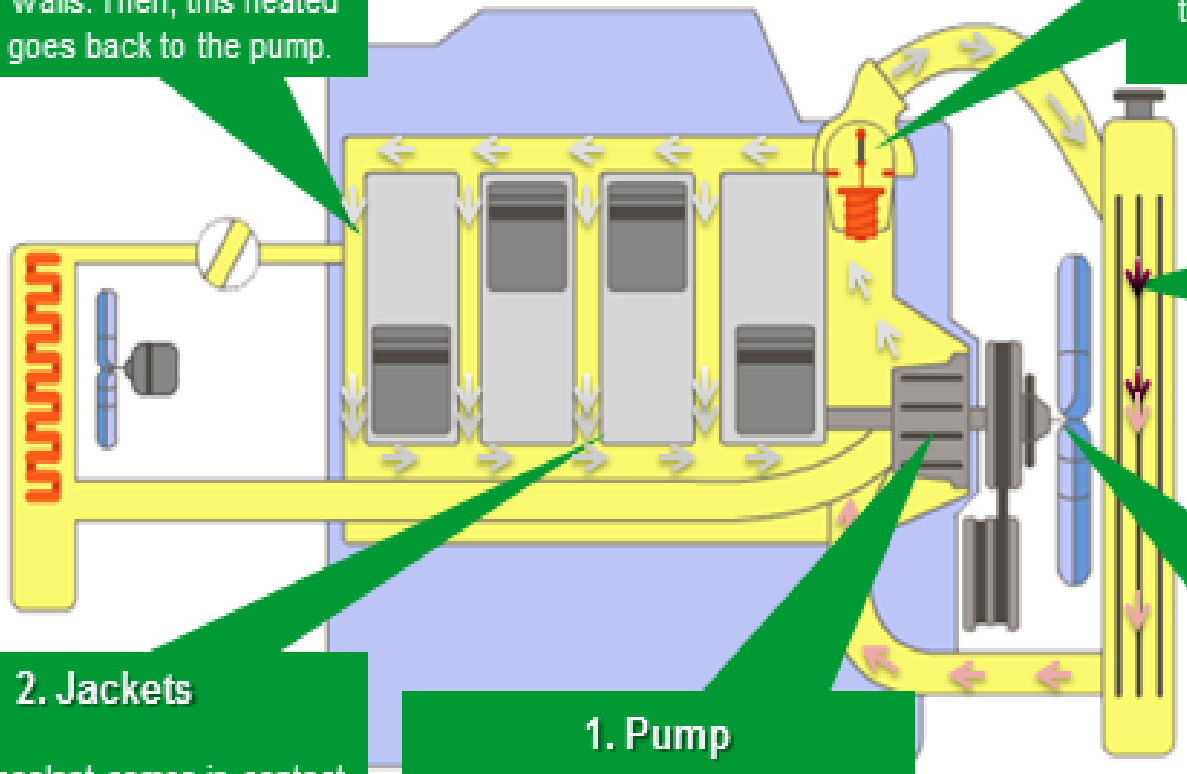
Higher engine temperatures

Pistons will seize, leading to engine failure

50% of all engine downtime is usually due to **cooling system failure**

Thus, engine coolants are used to keep engine's temperature at the right operating level.

COOLING SYSTEM



3. Cylinder Walls

Takes the heat from these cylinder walls. Then, this heated coolant goes back to the pump.

4. Thermostat

If the temperature of the coolant increases beyond a set limit, the thermostat placed in the system gets actuated.

5. Radiator

Thermostat then sends the coolant to the radiator.

6. Cooling Fan

The cooling fan blows air over the radiator. This flowing air cools the hot coolant. The cooler coolant coming out of the radiator is then pumped back into the engine block.

2. Jackets

Here the coolant comes in contact with the hot cylinder walls.

1. Pump

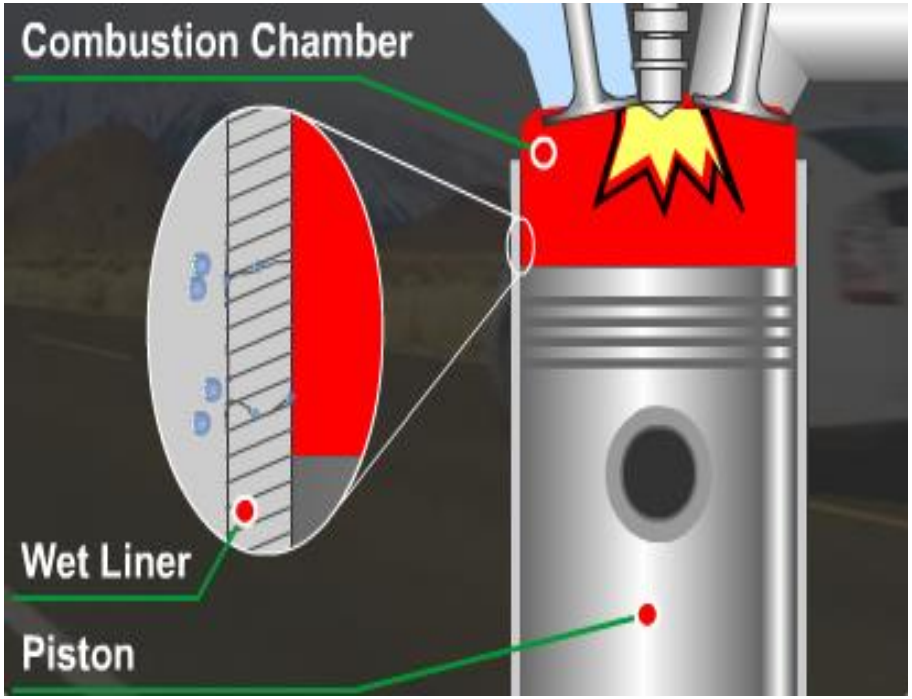
Sends the coolant to the jackets.

NEED FOR A COOLING SYSTEM

DO YOU KNOW THAT UP TO 80% OF ALL ENGINE DOWNTIME IS USUALLY DUE TO COOLING SYSTEM FAILURE OR DUE TO LACK OF MAINTENANCE OF THE SYSTEM RATHER THAN THE ENGINE ITSELF?

If the engine gets overheated due to lack of coolant:

- Air bubbles might form and burst on the outside of the cylinder liner walls
- A wet liner is a cylindrical part that is fitted into an engine block which can be in direct contact with the coolant from outside
- These air bubbles could then repeatedly burst and cause erosion of the liner, which may progress into the combustion chamber



THUS, ENGINE COOLANTS ARE USED TO KEEP ENGINE'S TEMPERATURE AT THE RIGHT OPERATING LEVEL.

GETTING THE COOLANT RIGHT

WE CAN'T USE TAP WATER OR BOREHOLE WELL WATER AS IT IS NOT SUFFICIENT TO ACT AS A COOLANT.

What if we use water instead of an engine coolant?

- Leads to corrosion and scaling of engine components
- Freezing of water in extreme winter; also, ice can exert pressure on the cylinder walls, causing them to crack
- Loss of water due to evaporation in extreme hot weather

Coolant can be diluted using water

Always use demineralised, distilled, or deionised water. If not, then:

- Scales begin to form – causing hot spots and liner deterioration
- Hard or bore well water may contain dissolved mineral salts – at general engine operating temperatures, it can be very corrosive and seriously reduce the corrosion inhibitor reserves of the coolant. This can result in cooling system failure.

It is recommended to use Castrol's pre-mixed 50-50 coolant

Coolant Elements:

Corrosion inhibitors

+

Ethylene glycol

Engine coolants

GETTING THE COOLANT RIGHT

THE RIGHT COOLANT MAXIMIZES ENGINE LIFE

The right coolant provides the following:

- Year-round cooling
- An engine-cooling system that protects against metal erosion, cavitations, coolant boiling, coolant freezing, and corrosion
- Compatibility with the various metals and non-metals present in the cooling system

CASTROL ANCILLARY PRODUCTS

Castrol Ancillaries	
Product	**Specifications**
Radicool SF	ASTM D3306 (1); ASTM D4985; BS 6580:2010; JIS K2234 MAN 324 type SNF; Ford WS-M97B44-D; MB-Approval 325.3
Radicool SF Premix	ASTM D3306 (1); ASTM D4985; BS 6580:2010; JIS K2234 MAN 324 type SNF; Ford WS-M97B44-D; MB-Approval 325.3
Radicool NF	ASTM D3306, ASTM D4985; BS - BS6580:2010; JASO JIS K2234 MAN 324 Typ NF; MB-Approval 325.0; MTU MTL 5048; VW TL-774C (G11); BMW approval for all models
Radicool NF Premix	ASTM D3306, ASTM D4985; BS - BS6580:2010; JASO JIS K2234 MAN 324 Typ NF; MB-Approval 325.0; MTU MTL 5048; VW TL-774C (G11); BMW approval for all models
Brake Fluid DOT 4	JIS K2233; SAE J1703; SAE J1704; ISO 4925 Class 4 FMVSS DOT 4

SUMMARY

In this session, we learnt about:

- How do the various systems in a vehicle work?
- What are the different types of lubricants used in these systems?

GREASE

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol

WHAT IS GREASE?

GREASE IS A SEMI-SOLID LUBRICANT CONTAINING BASE OIL, THICKENER AND ADDITIVES.

90% Base Oil

- Determines how effectively grease can lubricate
- Usually mineral oil; however, vegetable or synthetic oil may also be used.

10% Thickener

- Provides structure to hold the oil
- Acts as a non-elastic sponge, releasing oil during operation
- Protects the surface by reducing wear
- Can be Bentone, clay, or soap (calcium, sodium or lithium)

Additives

- Additives are put in to enhance the properties of grease.
- E.g. - oxidation and corrosion resistance

WHAT ARE THE FUNCTIONS OF GREASE?

- Lubricate, seal and stay in place
- Prevent contaminants from entering the equipment
- Prevents rust and corrosion
- Reduces friction

Note: Grease does NOT perform cooling and cleaning of component.

Grease is used where:

- Infrequent lubrication is required
- Lubricating oil will not stay in place

WHAT ARE THE PROPERTIES OF AN IDEAL GREASE?

1	Consistency	Good	4	Water separation (Demulsibility)	High
2	Shear Stability	Good	5	Oil separation	Adequate
3	Load carrying ability	High	6	Oxidation resistance	High

Consistency

- When a force is applied to grease, the degree to which it resists deformation is determined by its consistency
- Consistency measures the ability of grease to stay in place and seal
- So, grease should have good consistency

Load carrying ability

- Under extreme pressure loads, if the lubricant film is thin & not adequate, the moving surfaces may come in contact & result in surface wear
- So, grease should have good load carrying ability

Oil separation

- When grease is not in use, e.g., during storage conditions, the oil in grease separates from it
- Excess oil separation may cause grease to lose its ability to lubricate effectively
- So, oil separation in grease should not be excessive

WRITE DOWN THE CRITERIA FOR SELECTING AND RECOMMENDING A GREASE

Which component needs to be lubricated?

It can be Roller or Plain bearings, Enclosed Gears, Open Gears, Chains, Flexible joints.
If bearings need to be lubricated, consider the bearing design, speed, size, mounting arrangement, loading.

Is the application exposed to water?

The component to which grease is applied may be exposed to water; in such cases, the selected grease type must have ability to repel water under operating conditions.

What will be the operating temperature?

Grease needs to operate at temperatures less than its Drop point. So, knowing the operating temperatures will help you to choose the right Grease.

Shock loading/Extreme pressure requirements

The grease type selected will depend on the type of load the grease is expected to carry.

Is there a possibility of mixing with other lubricants or grease?

When greases with different soaps are mixed, both grease types tend to soften, affecting their ability to lubricate.

Are there any manufacturer's recommendation?

Manufacturers of a machine component give specifications of grease in the maintenance instructions or design specifications.

NLGI CONSISTENCY CLASSIFICATIONS

THE NATIONAL LUBRICATING GREASES INSTITUTE (NLGI) CLASSIFIES GREASE BASED ON CONSISTENCY OR STIFFNESS FROM 000 WHICH IS RUNNY TO 6 WHICH IS VERY HARD. THE CONSISTENCY MOST WIDELY USED IS NUMBER 2 FOLLOWED BY NUMBER 3.

NLGI consistency number	Worked penetration (*)	
000	445 - 475	Semifluid. Gear greases small bore centralised systems
00	400 - 430	
0	355 - 385	Centralised lubrication systems
1	310 - 340	
2	265 - 295	Usual bearing lubrication
3	220 - 250	
4	175 - 205	Very stiff (4) to block greases Rarely used
5	130 - 160	
6	85 - 115	

GREASE COMPATIBILITY

REMEMBER: Never mix greases with different thickener types.

Always check compatibility

GREASE COMPATIBILITY CHART

THICKENER	Aluminum Complex	Barium Soap	Barium Complex	Bentone (Clay)	Calcium Stearate	Calcium 12 Hydroxy	Calcium Complex	Calcium Sulfonate	Lithium Stearate	Lithium 12 Hydroxy	Lithium Complex	Polyurea	Silica Gel	Sodium Soap
Aluminum Complex		I	I	I	I	C	I	B	I	I	C	I	C	B
Barium Soap	I			I			B	B	B		B		C	I
Barium Complex	I			I	I	C	I	C	I	I	I	I		I
Bentone (Clay)	I	I	I		C	C	I	I	I	I	I	I	C	I
Calcium Stearate	I		I	C		C	I	C	C	B	C	I		
Calcium 12 Hydroxy	C		C	C	C		B	B	C	C	C	I		
Calcium Complex	I	B	I	I	I	B		I	I	I	C	B	I	I
Calcium Sulfonate	B	B	C	I	C	B	I		B	B	C	I	B	I
Lithium Stearate	I	B	I	I	C	C	I	B		C	C	I	C	I
Lithium 12 Hydroxy	I		I	I	B	C	I	B	C		C	I		
Lithium Complex	C	B	I	I	C	C	C	C	C	C		I	C	I
Polyurea	I		I	I	I	I	B	I	I	I	I			I
Silica Gel	C	C		C			I	B	C		C			I
Sodium Soap	B	I	I	I			I	I	I		I	I	I	

I=Incompatible, C=Compatible, B=Borderline

AUTOMOTIVE GREASES - SUMMARY

Castrol Product	Soap Base	NLGI No.	Drop Point ºC	Additive	Max Operating Temperature ºC	Application
LM Grease 2	Lithium	2	195	-	120	Multi purpose, chassis lubrication, wheel bearings
MS Grease	Lithium	2	182	-	130	CV Joints
WB Grease	Lithium	3	180	-	120	Slow speed wheel bearings in mining and construction vehicle
LMX Grease	Lithium Complex	2	275	EP	180	High speed wheel bearings in cars with ABS
BNS Grease	Bentonite Clay	2	NON-MELT	-	160	High speed wheel bearings

INDUSTRIAL GREASES - SUMMARY

Castrol Grade	Soap Base	NLGI	Drop Point	Additives	Max Operating Temp. ºC	Application
Spheerol EP2	Lithium	2	192	EP	130	General purpose industrial grease for shock-loaded bearings
Spheerol AP3	Lithium	3	180	-	120	Plain and anti-friction bearings, electric motors
Spheerol EPL O (Semi-fluid)	Lithium	0	170	EP	130	Centralised lubrication systems and grease filled gearboxes
Spheerol SX2	Calcium	2	>280	Slight EP, Tackifier	140	Highly water resistant – for marine, wire ropes, high speed bearings

HEAVY DUTY GREASES FOR EARTHMOVING

Castrol Product	Soap Base	NLGI	Drop Point	Additive	Max Operating Temp. ºC	Application
Spheerol LMM	Lithium	2	180	3% MoS_2, EP	130	Heavily loaded bearings at low and medium speeds, pivot pins, cams, screws, splined shafts, slides, flexible joints
Spheerol HD	Lithium Complex	2	>240	5% MoS_2, EP, Tackifier	150	Heavy duty and high temperature applications in areas of severe operating and climatic conditions, chassis, highly loaded kingpins, U-joints, bucket pins, fifth wheels and open gears

HYDRAULIC FLUIDS

IT'S MORE THAN JUST OIL. IT'S LIQUID ENGINEERING.

Castrol

Viscosity Chart

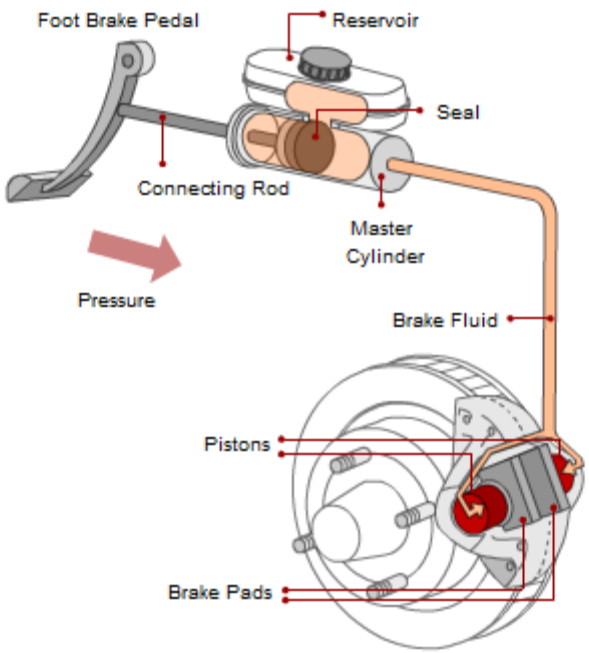
WHAT ARE HYDRAULIC SYSTEMS?

HYDRAULIC SYSTEMS ARE MACHINES THAT USE HIGH-PRESSURE, INCOMPRESSIBLE OIL HYDRAULIC FLUID, TO TRANSMIT FORCE.

Example of a Hydraulic System

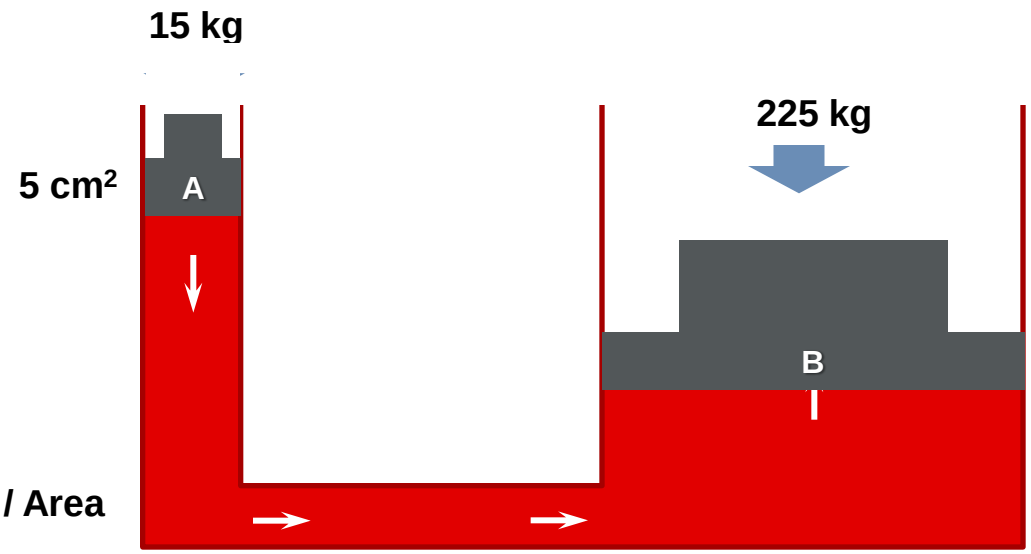
When you press the brake pedal in a car:

1. The pedal pushes the brake fluid through a tube
2. The fluid in turn presses the brake discs, thus reducing the speed of the car and stopping it



WHAT IS THE WORKING PRINCIPLE OF A HYDRAULIC SYSTEM?

Explain using this diagram



The incompressible fluid transmits the same pressure.

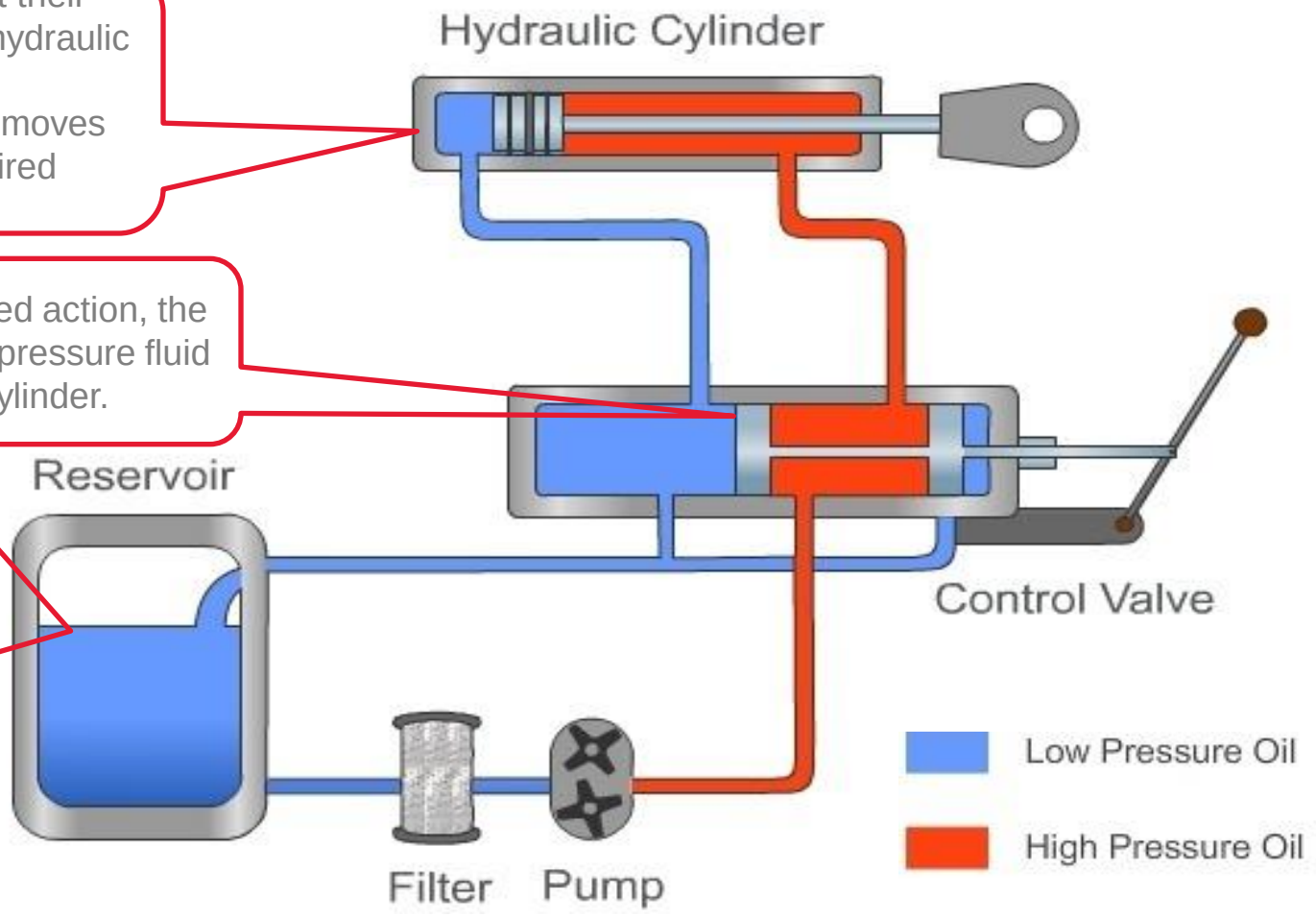
Pressure = Load / Area = 15 kg / 5 cm^2 = 3 kg / cm^2	Load = Pressure x Area = 3 kg / cm^2 x 75 cm^2 = 225 kg

HOW DOES A HYDRAULIC SYSTEM WORK?

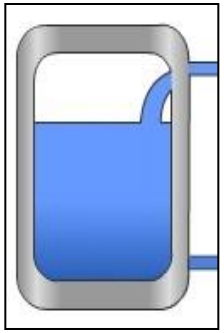
- Hydraulic cylinders get their power from pressurized hydraulic fluid.
- The hydraulic pressure moves the piston in the desired direction.

- Depending on the intended action, the control valve sends high-pressure fluid to the Hydraulic Cylinder.

- Hydraulic fluid is stored in the Reservoir.
- It is passed through the filter before sending it to the pump.
- The pump uses mechanical energy to pressurize the fluid



WHAT ARE THE FUNCTIONS OF EACH COMPONENT OF A HYDRAULIC SYSTEM?

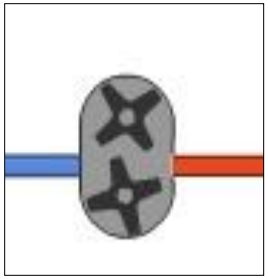


Reservoir

- Stores hydraulic fluid
- Cools or pre-heats fluid
- Removes bubbles from fluid
- Traps & removes contaminant

Filter

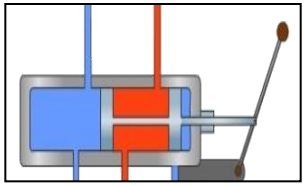
- Removes contaminants from hydraulic fluid



Pump

- Sucks fluid from the reservoir and passes it on to control valves.

Fluid Control Valves



- Send the high-pressure fluid to the Hydraulic Cylinder depending upon the intended action.

WHAT ARE THE FUNCTIONS OF A HYDRAULIC FLUID?

- Transmit the force
- Protect the Hydraulic System components thereby acts as a Lubricant & Coolant and reduces wear of moving parts.
- Extend the life of the Hydraulic System
- Lower maintenance costs

WHAT ARE THE PROPERTIES OF AN IDEAL HYDRAULIC FLUID?

1	Viscosity	Suitable
2	Viscosity index	High
3	Pour point	Low
4	Air separation (anti-foaming)	High
5	Anti-wear	High
6	Oxidation resistance	High

Compressibility

- It is the reduction in volume of a fluid when high pressure is applied.
- Hydraulic fluids need to transmit power without any loss, so compressibility has to be low.

Water separation (Demulsibility)

- If water mixes with hydraulic fluid it can:
  - Reduce the lubrication properties of the fluid
  - Corrode the hydraulic system's components
- So, the hydraulic fluid should be able to separate water (High demulsibility).

Shear stability

- As the hydraulic fluid passes through system components, long-chain polymers in the fluid break (shearing).
- This results in hydraulic fluid losing its viscosity and viscosity index.
- So, the hydraulic fluid should have high shear stability.

WRITE DOWN THE CRITERIA FOR SELECTING AND RECOMMENDING A HYDRAULIC FLUID

Viscosity Requirements:
The viscosity of the fluid should be close to the ideal viscosity recommended for the pump.

Operating temperature:
If a system operates at varying temperatures, hydraulic fluids need to have a high viscosity index.

Manufacturer's recommendation:
Consider the recommendations of the manufacturer on specifications of the fluid

Material Compatibility:
The hydraulic fluid and its additives should not adversely affect the different materials in the system.

Environment in which the system operates:

- Environmental factors such as extreme temperature and humidity may affect the performance of the oil.
- Use recyclable or environmentally acceptable fluid, if there is a possibility of environmental contamination by leaking fluid.

CASTROL HYDRAULIC OILS RANGE

RANGE	DESCRIPTION	HYDRAULIC PERFORMANCE	ISO CLASS (DIN CLASS)	Viscosities Available (1)	BASE FLUID	ADDITIVE TYPE	VISCOSITY INDEX (2)	FZG (A/8.3/90) FAIL STAGE (3)
Hyspin AWS	Highly refined mineral oil based anti-wear hydraulic and circulating lubricant containing a stabilised zinc additive system.	✓	HM (HLP)	15 - 150	Mineral	Anti-wear (zinc)	>95	11/12
Hyspin HLP	Highly refined mineral oil based anti-wear hydraulic and circulating lubricant containing ashless sulphur phosphate additive system	✓	HM (HLP)	32, 46, 68, 100	Mineral	Anti-wear (sulphur phosphate)	96 - 104	10
Hyspin AWH-M	High viscosity index, highly refined mineral oil based anit-wear hydraulic lubricant containing a stabilised zinc additive system.	✓✓	HV (HVLP)	15, 32 - 150	Mineral	Anti-wear (zinc) + Viscosity index improver	>130	11/12