ENGINE DISPLACEMENT

Engine displacement is defined as the total volume of air/fuel mixture an engine can draw in during one complete engine cycle; it is normally stated in cubic inches, cubic centimeters, or litres. In a piston engine, this is the volume that is swept as the pistons are moved from top dead center to bottom dead center.

Displacement

Displacement is equal to the volume of combustible air/fuel mixture ingested during one cycle of all the cylinders at 100% volumetric efficiency. Thus, a four-stroke engine ingests its displacement in combustible mixture in two engine revolutions, while a two-stroke engine needs only one engine revolution to do so.

Displacement-calculation

Standard engines

In a standard piston engine (an Otto or Diesel engine), displacement is calculated by multiplying the number of cylinders in the engine with the area of a piston and the length of the stroke. With circular pistons, displacement can be calculated from the bore diameter and stroke using the following formula:

$$\frac{\pi}{4} \times \text{bore}^2 \times \text{stroke} \times \text{number of cylinders} = \text{displacement}$$

Other engines

Displacement in other engine types (especially for a Wankel engine) is much more complicated.

Engine power

Engine power is thus dependent on the quantity of air/fuel mixture ingested and the efficiency of its combustion and conversion into power.

Variation

To increase the quantity of mixture combusted, the engine displacement can be increased, the speed of operation of the engine can be increased, or the mixture can be delivered at a higher pressure, which is the function of such devices as turbochargers and superchargers. See engine tuning.

All other factors being equal, a larger displacement engine is therefore more powerful than a smaller one. It is the easiest method of adding power since it neither requires higher rotational speeds nor complicated

auxiliaries. The ease of adding power this way (along with the lack of performance effects such asturbocharger lag caused by the time needed to spin up the turbine of the turbocharger) led to the sayingsThere's no substitute for cubic inches or, alternatively, There's no replacement for displacement commonly quoted by devotees of large-engined cars.

The added mass and size reduce a vehicle's maneuverability however, and in applications where that is important, alternative methods for increasing power are commonly employed. Additionally, because the efficiency of the engine is not improved, fuel consumption rises dramatically.

Usage-engine capacity

In cars, engines over 8 litres displacement are extremely rare in the last half-century and most modern cars utilise engines much smaller than that: in the United States, 1 to 2 litres for smaller cars, 3 to 5 litres for larger and faster cars; in Europe, cars with a displacement larger than 2 litres are rare, due to taxation discouraging the use of fuel-inefficient cars.

Five to 10 litre engines are used in many single and twin engine propeller-driven aircraft. Much larger engines tend to be diesel engines fitted to trucks, ships, railroad locomotives and those used to drive stationarygenerators. The displacement of each cylinder in such an engine may be much larger than that of a whole car engine.

Governmental regulations

In many nations levels of taxation on automobiles have been based on engine displacement, rather than on power output or vehicle weight. Displacement is easy to identify and difficult to modify whereas power output must be tested. This has encouraged the development of other methods to increase engine power.

There are four major regulatory constraints for automobiles: the European, the British, the Japanese, and the American. The method common to some European countries, and which predates the EU, has a level of taxation for engines over one (1.0) litre and another at the level of about 100 cubic inches, which is approximated to 1.6 litres. The British system is different than the European one even though it is in the Eu. It is very similar, except that the peculiar Royal Automobile Club formula for approximating the power of primitive engines was maintained over many decades instead of displacement (this calculation does not include the stroke of the piston).

The Japanese is similar to the European taxation by classes of displacement, plus a vehicle weight tax. It is only in the American system, which includes Canada, Australia, and New Zealand, that there is not this sort of taxation per engine displacement. Also, in The Netherlands, road tax is not based on engine displacement but on vehicle weight.

Capacity-decision

Displacement is also used to distinguish categories of (heavier) motorbikes with respect to license requirements. In France and some other EU countries, mopeds, usually with a two-stroke engine and less than 50 cm3 displacement can be driven with minimum qualifications (previously, they could be driven by any person over 14). This led to all light motorbikes having a displacement of about 49.9 cm3. Some people tunedthe engine by increasing the cylinder bore, increasing displacement; such mopeds cannot be driven legally on public roads; since the brakes of mopeds are generally not designed for speeds above 45 km/h, they are a safety hazard.

Wankel engines, due to the amount of power and emmissions they create for their displacement, are generally taxed as 1.5 times their actual physical displacment (1.3 litres becomes 2.0, 2.0 becomes 3.0), although actual power outputs are far greater (the 1.3 litre 13B can produce power comparable to a 3.0 V6, and the 2.0 litre 20B can produce power comparable to a 4.0L V8). As such, racing regulations actually use a much higher conversion factor.

Example regulations

Bulgaria: a special tax on non-European cars over 2.8 L, later amended to over 3.0 L

Belgium and Portugal have a proportional tax including reference to displacement

Ireland: under 1.4 L; 1.4-1.9 L; over 1.9 L

Korea: under 0.8 L; 0.8-2.0 L; over 2.0 L

Netherlands: proportional tax based on vehicle weight, fuel type and region.

Philippines (proposal from 2000): under 1.6 L; 1.6-2.0 L; 2.0-2.8 L; over 2.8 L

Spain: under 1.6 L; over 1.6 L

Taiwan: under 500 cc, 500~600 cc, 601~1200 cc, 1201~1800cc, etc (increments of 600 cc up to 8400 cc, where generally the price difference is greater from one range to the next).

Engine capacity-trend

Considering the world situation on the trend of supply of petroleum fuel, manufacturers of cars have not only gone to smaller capacity engines but also to alternative fuels for the same.

Conversions

1 L ~ 61 $inch^3$

1 $inch^3$ ~ 16 cm^3

The big engines listed above are mostly 7.0 litres. The 3.5 litre engines listed on American cars today as being large are much smaller than the 350 cubic inch (5.7 L) engines that once were considered medium size.

The 3.5 litre engine is 213 cubic inches. The 1964 Mustang's smallest Ford V8 engine of 289 cubic inches is 4.7 litres.

However, modern electronically-controlled engines these days are much more efficient, and the cars they are fitted in are lighter, so the difference in performance is not as great as might otherwise be supposed.

Source : http://engineering.wikia.com/wiki/Engine_displacement