

How to Improve Energy Efficiency by Proper Vehicle Maintenance

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The fuel crisis which commenced in 1973, made the automobile users conscious of fuel economy. With the world demand for automobiles declining, and automobile giants like General Motors and Chrysler Corporation being faced with the prospects of having to close down a few of their factories, the automobile industry is now facing severe competition and is struggling to exist, competing to meet the consumers' demand for power and fuel economy. Advertisements carrying a mass of information, both speculative and factual have been generated by competing manufacturers about fuel consumption, multi valve engines, twin overhead cam engines, turbocharged engines etc. Fuel consumption plays a very important part from the manufacturer's point of view, not only because of its concern by their customers, but also because of the American Federal regulations which specify the maximum average fuel consumption of automobiles manufactured by any American manufacturer or imported into America by a dealer. Figure I shows the Corporate Average Fuel Economy standards for passenger cars from 1978 to 1985. The CAFE standards might be anywhere from 40 to 85 miles per gallon by the year 2000.

There are a number of factors which influence the fuel economy of an automobile. Some of them are optimized during the stages of design and manufacture and have subsequently to be maintained by an automobile repair shop or a competent motor mechanic. The design factors are

1. Compression Ratio
2. Ignition timing/ fuel injection timing
3. Valve timing
4. Preparation of correct air/fuel mixture, and
5. Steering geometry

The factors which influence fuel consumption and have to be looked after by the automobile user are :

1. Tyre pressures
2. Type of tyre used (Cross ply or radial type)
3. Driving speed
4. Driving habits
5. Cleanliness of air cleaner and
6. Viscosity of Lubricating oil

The Compression Ratio

The efficiency of an engine increases as the compression ratio increases. But as the compression ratio increases,

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a better fuel, having a higher octane number, has to be used. When the cylinder and piston rings wear out the effective compression ratio reduces and fuel consumption increases, due not only to the decrease in the effective compression ratio, but also due to the leak between the pistons and cylinder walls.

Ignition timing

The ignition timing or the time at which the spark occurs and initiates combustion, has an important bearing on the power output and consequently on the fuel consumption, as shown in figures II & III. The best time for the spark to occur depends upon a large number of factors, of which the load, speed and air / fuel ratio are the three main ones.

The classical ignition systems had only a mechanical governor and vacuum controlled device to cater for variations in speed and load only, and that too, they did in the manner indicated in the space graph shown in figure IV. The ideal ignition timing with respect to load and speed, taking other variables also into account, is shown in the space graph given in figure V. This was achieved by some manufacturers using microprocessors having upto eleven inputs. But now with the vast amount of experience they have gained in the recent past, automobile manufactures have been able to simplify the engine electronics by using only two sensing devices. A knock sensor which feeds in a signal and optimises the ignition timing and a lambda sensor which feeds in a signal and optimises the fuel / air mixture.

Fuel injection timing

The fuel injection timing of a compression ignition engine is as critical as ignition timing in a spark ignition engine, as far as the power and fuel consumption are concerned. But the optimum fuel injection timing is not so sensitive to

variations in speed or load as the ignition timing is for a spark ignition engine. These variations, even if catered for, would be around one to five degrees for commercial diesel vehicles. But for large engines as used in locomotives, power stations and ships, the injection timing is varied both according to speed and load, as the very small percentage of fuel thus saved, would work out to be a large amount of fuel in these cases, and would be worth the additional and more complex equipment installed.

Valve timing

The times at which the inlet and exhaust valves open and close will influence both the power and fuel efficiency of the engine. Although the optimum valve timing varies with the speed, there are still no production models, having this facility. Therefore design considerations produce engine characteristics of torque, volumetric efficiency and specific fuel consumption which reach optimum values around 2000 to 3000 r.p.m. while the maximum engine speeds are around 5000 to 7000 r.p.m. Therefore, if fuel consumption is the main consideration, driving too slow or too fast will be uneconomical. If the car has a revolution counter the engine speed could be monitored not to fall below or rise above the 2000 - 3000 r.p.m. range for best fuel economy.

Preparation of the correct air/ fuel mixture

This will apply only to spark ignition engines. The flame speed and consequently, the time taken for combustion, varies with the air/ fuel ratio and the degree of mixing or turbulence in the mixture. The stoichiometric mixture always gives the highest speed and increases as the degree of turbulence increases. Since the flame speed is closely linked with the ignition timing, the full benefits of any alterations of the air/ fuel ratio or degree of turbulence can be reaped only with corresponding changes in the ignition timing. It is possible to economise on fuel by weakening the mixture and increasing the turbulence to regain the original speed of combustion. Turbulence can be increased by introducing an impeller or a system of vanes in the path of the mixture in a carburettor system; or by restricting the inlet valve opening and supercharging in the case of a petrol injection system, producing a partial type of valve throttling.

Steering Geometry

Setting the correct toe-in or toe-out and adjusting the castor and camber angles to the manufacturers' values, will produce perfect rolling of the front wheels of a vehicle when travelling along a straight path and give the minimum of scrubbing while negotiating curves, keeping the

rolling resistance at a minimum. The power required to propel a vehicle is made up of -

1. Power to overcome rolling resistance
2. Power to overcome aerodynamic drag
3. Power to overcome gravitational force when going up and incline, and
4. Power to accelerate the vehicle

The tyre pressure plays an important part in the rolling resistance which increases as the pressure decreases, and vice-versa as shown in fig VI. The type of tyre used, Radial - ply or Cross - ply, and to a small extent even the thread pattern affects the resistance to motion and consequently the fuel consumption as shown in fig VII

If the driving speeds are below 60 m.p.h. the difference in resistance to motion offered by a radial-ply tyre and cross-ply tyre is small, but at higher speeds the difference becomes appreciable.

The fuel consumption of a vehicle will vary with the driving speed and driving techniques as shown in fig VIII

Fast driving and fuel economy are not compatible. At a steady speed of 80 m.p.h. in top gear, the fuel consumption may be twice as high as at 30 m.p.h. A car gives best performance, combined with fuel economy, at the speed at which the engine develops the maximum torque; usually between 2000 and 3000 r.p.m., at a road speed of around 50 m.p.h.

If the car has a revolution counter, the precise time at which the gears have to be changed is known. If it does not have one, the best time to change gears is at half the maximum speed recommended by the manufacturer for each gear. Always avoid peak revs in each gear as over - revving the engine can cause damage.

It is always economical to press the accelerator pedal gently even if it takes a little longer time to reach the speed that you want, unless you need the extra speed quickly for safety when overtaking.

Upto about 40 m.p.h. the aerodynamic drag on a vehicle is very small but beyond 40 m.p.h it starts increasing rapidly as shown in figure IX. Therefore for vehicles cruising at higher speeds it pays to have an aerodynamic design and avoid protrusions like wing mirrors, number plates, hood-racks etc., which increase the drag coefficient. At these speeds even the cleanliness of the surface

of the car body counts. Keeping it clean and polished brings down the drag coefficient and consequently the resistance to motion.

The air cleaner prevents the dust in the intake air reaching the engine and producing wear. It also damps the intake noise to comply with legal regulations pertaining to the overall vehicle noise level enforced in certain countries. Blockage of the air cleaner, particularly those having paper elements, amounts to choking of the inlet manifold, resulting not only in increased-fuel consumption, but also increased cylinder wear and some dilution.

An average sized engine would draw in 1 to 50gm of dust over 1000 km. depending upon the road conditions and vehicle use, and it is difficult to give a time interval at which the paper element should be replaced or wire mesh cleaned. The best indication that the air-cleaner needs attention can be obtained from a vacuum gauge connected to the inlet manifold. The normal reading of such a gauge on a non supercharged engine is 17 to 21 in Hg. A consistently higher reading than this indicates a choked air-cleaner.

The viscosity of the lubricating oil is a very important parameter that has to be monitored by the automobile user, as it influences engine performance, engine life and fuel consumption. The ideal would be to have a high viscosity oil while starting to produce better boundary layer lubrication and a low viscosity oil while running at high speed to reduce viscous drag while hydrodynamic lubrication takes place. No automobile manufacturer has pro-

vided for this, but they all recommend a viscosity value which reasonably caters for both these conditions.

Here it has to be stressed that under tropical conditions straight oils satisfy these conditions better than multi grade oils.

The degree of oiliness of a lubricating oil deteriorates due to sustained high temperature and frequent rapid acceleration. Hence, periodic oil changes becomes necessary. The time interval for oil changes will depend on the quality of the oil used and the type of driving the vehicle is subjected to. The colour of the oil is not a rigid indication of its quality, as modern oils contain additives which keep the carbon particles in colloidal suspension. Normal oil filters cannot trap these particles and hence the oil begins to darken within a few hours of use.

There are various simple tests that could be done to determine whether the oil is still usable, but it is convenient to stick to a time interval recommended by the manufacturer. Most fleet owners change oil at 10,000 mile intervals.

Dealing with fuel economy, it is appropriate to mention here that various emission control and fuel economy devices are being tried out in research laboratories all over the world and improvements in specific fuel consumption by upto 24% has been obtained by intake valve throttling. Transistorised ignition systems and idle jet cut-off at high speeds have also contributed in a large way to fuel saving in spark ignition engines.□

ENERGY EFFICIENCY IN BUILDING RESEARCH PROJECT ON TRACK

The SIDA funded Energy Efficiency in Building project gathered momentum with the arrival of Instruments and other accessories required for establishing the temporary laboratory. The laboratory has now been assembled at the Institute of Architects building at Vidya Mawatha. The testing is to commence suggestions regarding lighting research.

Dr. N Sandaratne has been appointed to evaluate the project on behalf of SIDA. He had a very fruitful discussions with the study team.

The first phase of the Thermal Comfort study is nearing completion except for the case studies. This study has enabled the automation of the entire procedure for pre-determining the performance Index of building by giving relevant parameters of the buildings. Prof. Folke Peterson's visit to Sri Lanka to review the progress of the project was very useful and he assured that he would present the case to SIDA for further funding. A request is being made to SIDA for further assistance to continue with the Research Project.

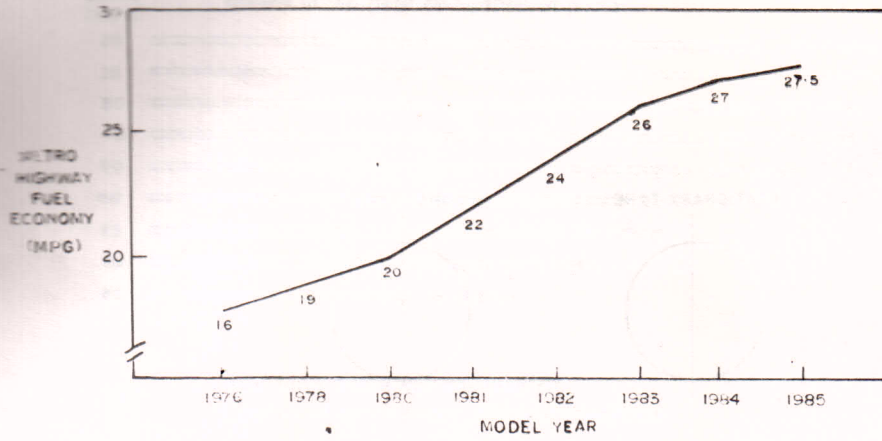
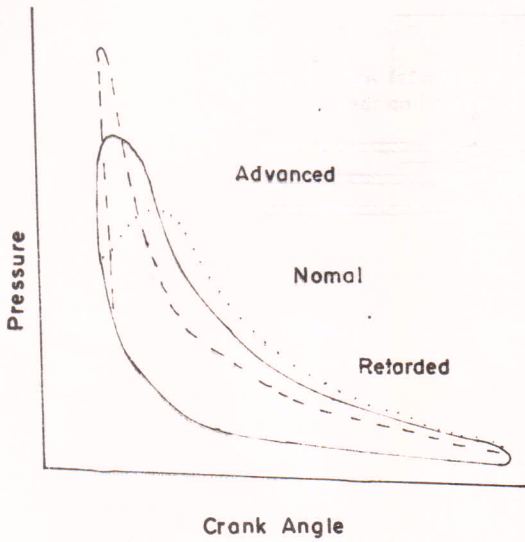


Figure I - Passenger Car CAFE Standards, 1978 - 85

Effect of Ignition Timing On Power



Effect of Ignition Timing On Fuel Consumption

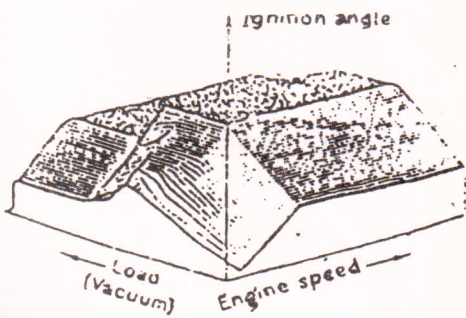
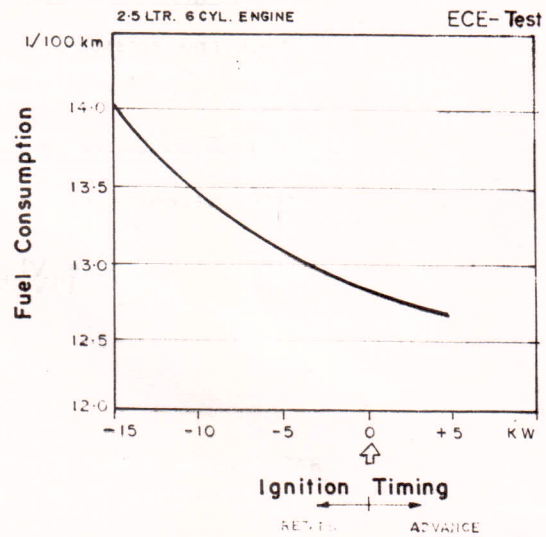


Figure II

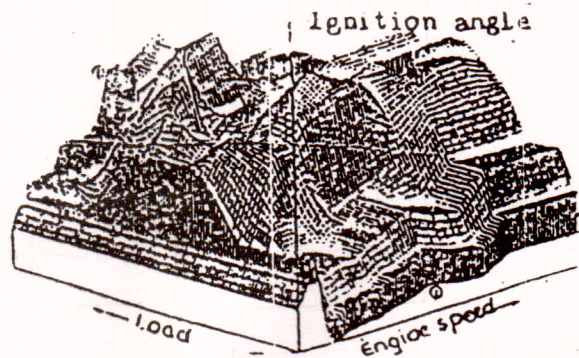


Figure III

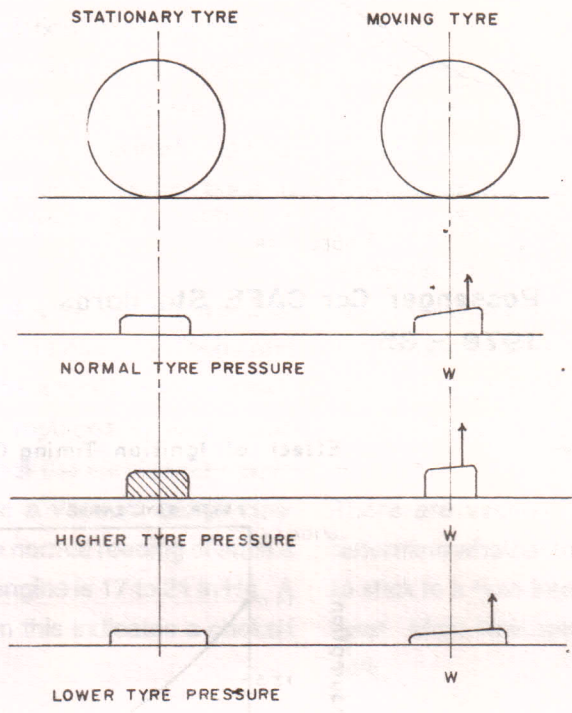


Figure VI.

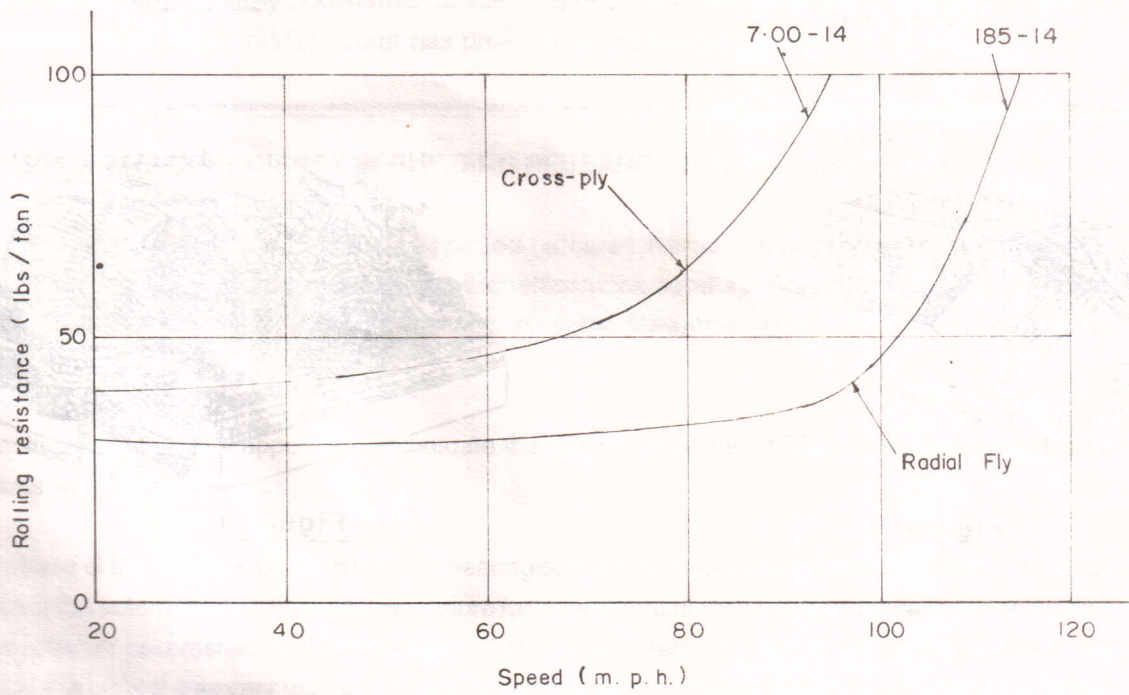


Figure VII.

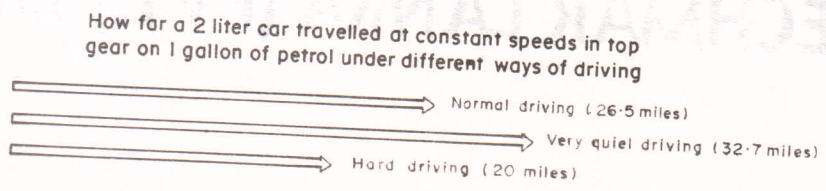
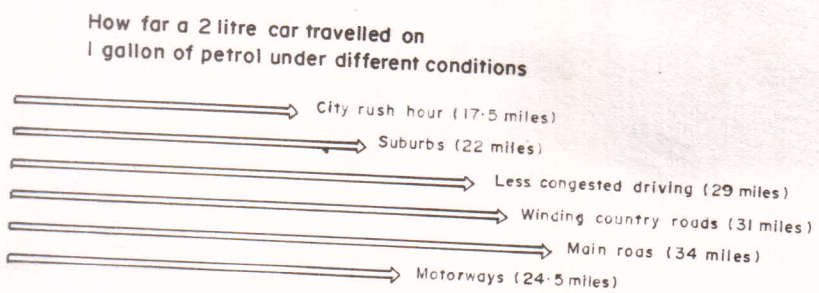
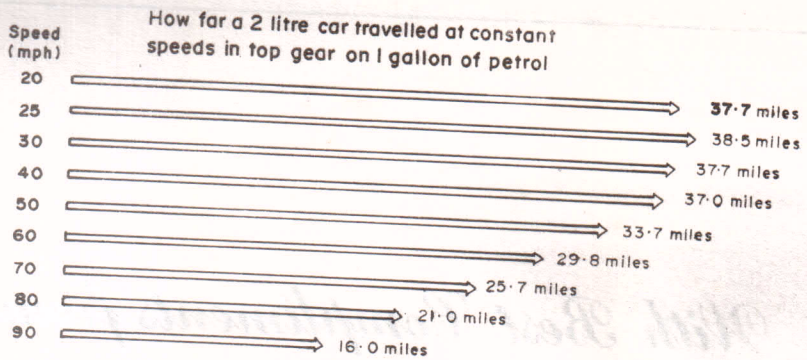


Fig VIII

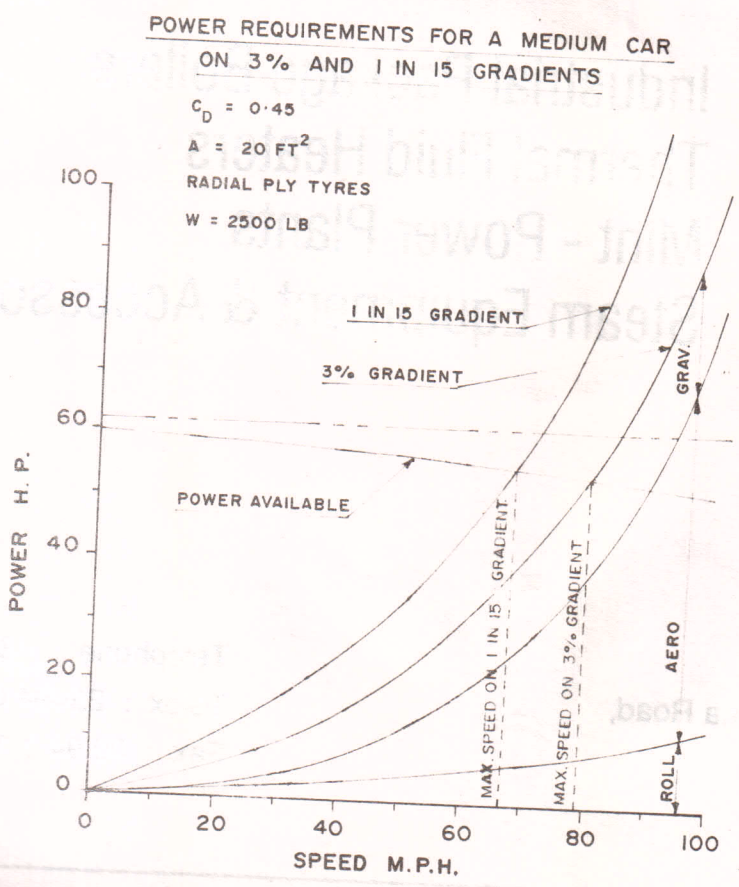


Fig IX