EFFECT OF ATMOSPHERIC TEMPERATURE ON THE PERFORMANCE OF A PETROL CAR

R.K.Pal[1*]

[1]Department of Mechanical Engineering,
Panjab University Swami Sarvanand Giri Regional Centre,
Hoshiarpur, India

ABSTRACT

The present work is to see the effect of atmospheric temperature on performance parameters like mileage, brake specific fuel consumption and thermal efficiency of a vehicle. Experiments were conducted on a car and parameters like mileage, thermal efficiency and specific fuel consumption were computed at various values of atmospheric temperature and speed throughout the year. The maximum mileage and thermal efficiency of the car was in the month of March. The minimum specific fuel consumption was for the month of March as compared to other months of the year. The maximum mileage and thermal efficiency obtained were 22.6 km/litre and 29.48% respectively at speed 1550 rpm, torque 38 Nm and average atmospheric temperature of 290 K. The minimum specific fuel consumption obtained was 0.275 kg/kWh at 1550 rpm speed, 38 Nm torque and average atmospheric temperature of 290 K. The performance of the car was best in the month of March.

***KEYWORDS**: Automobile, Specific fuel consumption, Thermal efficiency, Atmospheric temperature, Torque*

1.0 INTRODUCTION

The demand of energy is increasing very fast, but the main source of energy is still fossil fuels which has very limited reserves. Around half of the world energy consumption is fulfilled by fossil fuel oil. Transport sector consumes a major share of the world energy utilization. Around 60% of world oil consumption is in transport sector, within this sector 80% of the total oil consumption is in road transport alone (Silitonga et al. 2012). This sector is growing very fast due to steady increase in motorization and urbanization in developing countries. Increase in energy consumption for non-road transport modes was 13% between 1990 and 2005 while that in road transport energy consumption was 41% (Daniel, Manfred & Felix, 2010). Estimates tell that the energy use

* Corresponding author email: ravinder_75@yahoo.com

for road vehicle will increase by 1.4% annually up to 2030 (Silitonga et al. 2012 and Takao, 2008). Transportation sector produces 25% of total world carbon dioxide (CO_2) emissions; in this sector road transport produces 10% of greenhouse gases (GHG) emissions globally (Silitonga et al. 2012). These greenhouse gases cause global warming and other health related problems. Estimates tell that the CO_2 emissions for road vehicle will increase by 1.3% annually up to 2030 (Silitonga et al. 2012 and Takao, 2008). The annual fossil fuel consumption in transport sector can be decreased by improving the fuel efficiency of the transport vehicles. The fuel efficiency can be increased by increasing the engine efficiency which in turn will lower the CO_2 and other pollutants emission. The fuel efficiency of vehicles can be enhanced by utilizing existing improved engine & vehicle technologies (Bezdek and Wendling 2005 and Weiss et al. 2000). The methods to enhance engine efficiency are improving thermal efficiency, using continuously variable transmission and reducing aerodynamic drag & vehicle weight etc. All of these methods except thermal efficiency need redesigning of the car. Therefore these methods cannot be implemented on existing cars. The thermal efficiency of a vehicle can be improved by means of better radiators which loses more or less heat to surroundings depending on weather conditions. Air inlet temperature is one of the factors which influence radiator performance (Amrutkar and Patil, 2013). Determining the effect of atmospheric temperature on thermal efficiency is main task for design of such radiators. In summers the heat transfer and cooling capacity decreases with the increase in air inlet temperature (Oliet et al. 2007). In winters the heat transfer and cooling capacity increases with the decrease in atmospheric air temperature. So we can say that cooling capacity keeps on changing throughput the year. Keeping this literature review in mind the present work is to see the effect of atmospheric temperature on performance of the vehicle in terms of parameters like the mileage, brake specific fuel consumption and thermal efficiency. The parameters like fuel consumption, distance covered, atmospheric temperature, weight of passengers, speed of car were noted down and from these values, parameters like mileage of vehicle, power developed by engine, thermal efficiency of vehicle and break specific fuel consumption etc. were computed.

2.0 MATERIAL AND METHODS

The experiments were conducted on a petrol engine car throughout the year at various speeds. The atmospheric temperatures, speed of car, distance travelled, time, fuel consumption were noted down. The other parameters like temperature after compression, maximum temperature and exhaust temperature of the engine were computed from the inlet temperature using the formulae and data available in the literature and given in the appendix. The index of compression is taken as 1.35 (Pulkrabek, 1997). The speed of the engine (in rpm) was calculated from the velocity of the car using the formula given in the appendix. The torque was computed from the normal force which was calculated from the weight of the car and that of passengers using formulae given in the appendix. The road/tyre friction factor was taken as 0.9 (Ghandour et al. 2010). The brake power was computed from the speed of engine and torque using the formula given in appendix. Mass of fuel (in kg) was calculated from the volumetric fuel consumption (in litre). The thermal efficiency of the engine was calculated from the calculated values of brake power, mass of fuel and calorific value of fuel available in the literature using the formula given in appendix. Brake specific fuel consumption was calculated from the brake power and mass of the fuel consumed using the formula given in the appendix.

3.0 RESULTS AND DISCUSSIONS

The average atmospheric temperature (Figure 1) increased from the month of January to June and decreased afterwards up to December. The maximum average atmospheric temperature was for the month of June. The temperature after compression, maximum temperature and exhaust gas temperature (Figure 2) increased from the month of January to June and then decreased up to the month of December. This is because the atmospheric temperature increased from the month of January to June and decreased afterwards. Therefore the heat transfer from the engine in the form of unaccounted loss decreased up to June which in turn increased all these temperatures. The heat transfer from the engine increased afterwards which decreased all these temperatures.

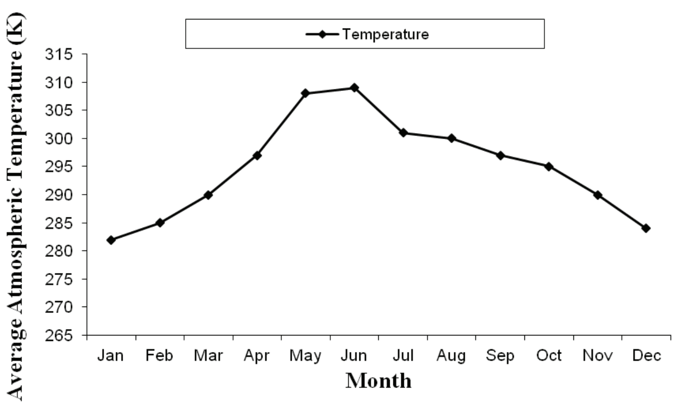

Figure 1. Monthwise average atmospheric temperature variation

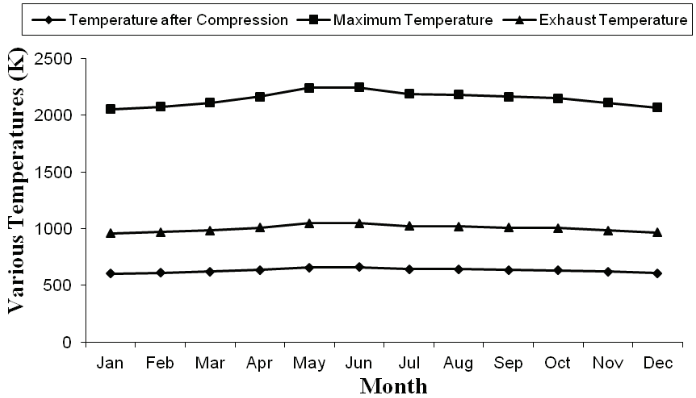

Figure 2. Monthwise variation of various temperature

The thermal efficiency (Figure 3) and mileage (Figure 4) of the car increased from the month of January to March due to increase in the maximum engine temperature due to which thermal efficiency of the car increased which in turn increased the mileage. The thermal efficiency and mileage decreased from March to June due to more increase in exhaust temperature although maximum temperature also increased. After that the thermal efficiency and mileage increased up to October due to decrease in lower temperature although higher temperature also decreased. These two parameters remained constant from July to August due to almost same amount of fall in upper and lower temperature. These two parameters decreased from October to December due to more decrease in higher temperature although lower temperature also decreased.

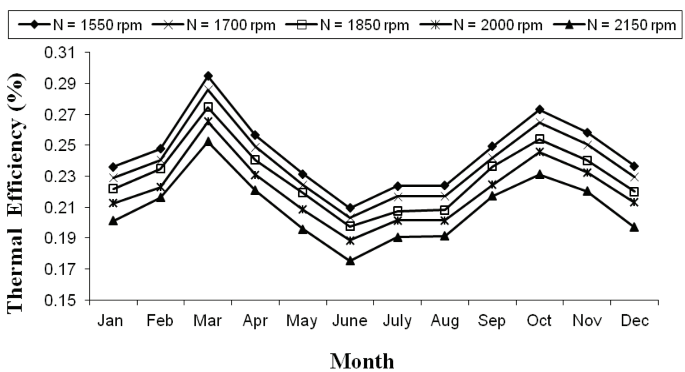

Figure 3. Monthwise car thermal efficiency at different speeds

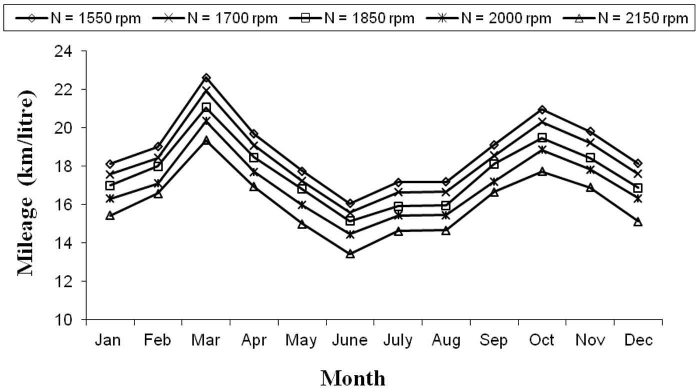

Figure 4. Monthwise car mileage at different speeds

The bsfc increased due to decrease in thermal efficiency from March to June. After that the bsfc decreased from June to October due increase in thermal efficiency. Then the bsfc increased from October to December due to decrease in thermal efficiency of the car engine.

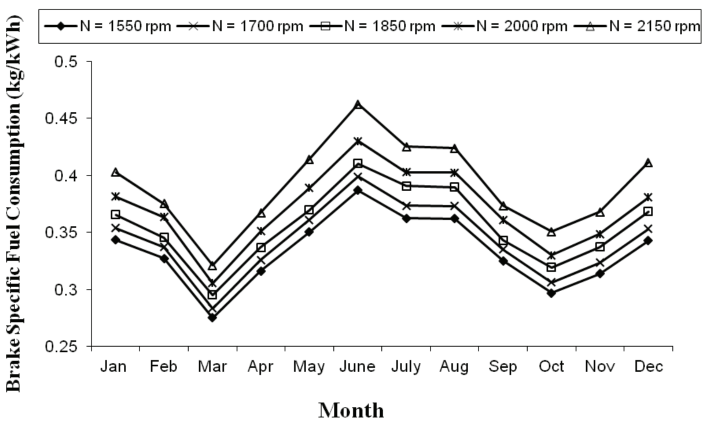

Figure 5. Monthwise car brake specific fuel consumption at different speeds

4.0 CONCLUSIONS

The maximum thermal efficiency and mileage of the car was for the month of March. The maximum value of the thermal efficiency and mileage of the car were 29.48% and 22.6 km/litre respectively at speed 1550 rpm, torque 38 Nm and average atmospheric temperature of 290 K. The minimum brake specific fuel consumption of the engine at various values of speed and at various values of torque was for the month of March. The minimum value of bsfc was 0.275 kg/kWh at 1550 rpm speed, 38 Nm torque and average atmospheric temperature of 290 K. The performance of the car was best in the month of March.

NOMENCLATURE

Various Temperatures

Inlet Temperature		$= T_1$
Temperature after compression		$= T_2$
Maximum temperature		$= T_3$
Exhaust Temperature		$= T_4$
Compression ratio		$= r$
Index of compression		$= \gamma$
Pressure ratio		$= \frac{P3}{P2}$
	T_2	$= T_1 * r^{\gamma-1}$
	T_3	$= T_2 * \frac{P3}{P2}$
	T_4	$= T_3 * (\frac{1}{r})^{\gamma-1}$

Torque (T)

Weight on each tyre		$= W$
Radius of tyre		$= R$
Road/Tire friction factor		$= \mu$
Normal force on tyre		$= F_N$
Friction force		$= F$
	W	= Total weight/4
	F_N	$= W$
	F	$= \mu * F_N$
	T	$= F * R$
Volume of fuel		$= v_f$
Distance travelled by the car		$= D$
Mileage		$= M$
	M	$= \frac{D}{vf}$

Speed of engine (N)

Gear ratio of transmission		$= gr_t$
Gear ratio of differential		$= gr_d$
Circumference of the tyre		$= C_t$
Velocity of car		$= V$
	N	$= \frac{(V * grt * grd)}{Ct}$

Brake Power (BP)

$$BP = \frac{2 * \pi * N * T}{60}$$

Thermal Efficiency (η)

Mass of fuel	$= m_f$
Calorific value of fuel	$= CV$

Thermal Efficiency (η)

Mass of fuel = m_f

Calorific value of fuel = CV

$$\eta = \frac{BP}{mf * CV}$$

Brake specific fuel consumption (bsfc)

$$bsfc = \frac{mf}{BP}$$

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