# Computation of Motor Rating for an Electric Vehicle Using Python

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**Abstract -** *All-electric cars, also called battery-powered cars, have an electric motor while the conventional vehicles have an internal combustion engine. The car uses an extensive pull-out battery pack to power the engine and should be connected to an outlet wall or charging device, also called an electric car supply equipment (EVSE). As motor plays an important role in EV's the following work aims at providing a simplified motor rating calculation using Python.*

***Key Words*: Motor torque, forces, power, traction, rolling resistance, aerodynamic drag.**

## 1.INTRODUCTION

Electric vehicles (EVs) are deeply flexible and are element of everyday society. Save fuel costs, control pollution, reduce running costs as they have slower components that will take care of them. EVs are less powerful or full of electricity. They work by connecting to a charging station and taking electricity from the grid. Electricity is stored in batteries and rechargeable batteries that power the engine, turning the wheels. It is a torque that constitutes details of the driving force of the wheels and helps the car to reach a state of motion. This paper presents the calculation of the car rating of the EV movement.

## 2. EV POWERTRAIN MODELLING

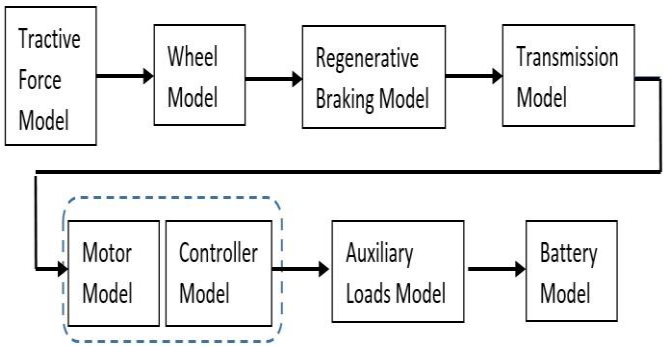


**Fig -1**: Block diagram of EV Powertrain

The above figure represents the powertrain component models in a typical EV simulator.

An EV Powertrain is the one which is responsible for taking energy stored in the vehicles battery system and supplying it to the motor.

## 3. TRACTIVE FORCE OR TRACTION

In general, tractive force or traction is the force needed to overcome the resistance caused by the friction.

Or

The term tractive force can either be attribute to the outright traction that a vehicle exerts on a surface, or the amount of the outright traction that is parallel to the direction of motion.

This type of force can be determined by using the formula given:

**FTT = FRR+ FAD+ FHC**

FTT: Total Tractive force

FRR: Force required to conquer Rolling Resistance

FAD: Force required to conquer Aerodynamic Drag or Resistance

FHC: Hill Climbing Force

## 4. FACTORS AFFECTING TRACTIVE FORCE

When choosing an electric car motor, a few factors should be considered in determining the Total Tractive Force. These features are:

1. Rolling Resistance
2. Aerodynamic Drag or Resistance
3. Hill Climbing

### 4.1 FORCE REQUIRED TO CONQUER ROLLING RESISTANCE

Resistance to wrap a merger of forces that work against the forward movement of the car. Vehicle mass, gravity and inertia, the extent of friction between the tires and the road surface, and gravity together all play a part.

In general, it is nothing but a resistance that opposes the rolling action of the wheel against the surface.

Formula to calculate Force required to overcome Rolling Resistance:

$$FRR = Urr \times MT \times g$$

Where:

Urr : Coefficient of rolling resistance

MT : Total Mass of Vehicle

g : gravitational pull

Values of Coefficient of rolling resistance:

| *Resistance* Contact Surface | Urr |
|---|---|
| Concrete(good/fair/poor) | 0.010/0.015/0.020 |
| Asphalt(good/fair/poor) | 0.012/0.017/0.022 |
| Macadam(good/fair/poor) | 0.015/0.022/0.037 |
| Snow(2 inch/4 inch) | 0.025/0.037 |
| Dirt(smooth/sandy) | 0.025/0.037 |
| Mud(firm/medium/soft) | 0.037/0.090/0.150 |
| Grass(firm/soft) | 0.055/0.075 |

### 4.2 FORCE REQUIRED TO CONQUER AERODYNAMIC RESISTANCE OR DRAG

It is a force that assails the movement of a car in the air. When the car is moving; removes air. However, it affects the speed and performance of the car. Technically, an aerodynamic pull or air-cooled collision in a moving vehicle.

Gravity is measured in terms of 15.5 degrees Celsius and standard atmospheric pressure of 1.003. But there are very few wind turbines, so the extra gravity due to the relative wind speed should be enumerated to the force required to conquer Aerodynamic Drag calculation. This is an added windshield that pushes the car away from random winds.

The force required to overcome the aerodynamic resistance or drag is:

$$FAD = \frac{1}{2} \times \rho \times A \times V^2 \times Cd$$

Where:

FAD: Force required to overcome Aerodynamic Drag or Resistance

$\rho$ : Air Density

$V^2$ : Velocity of Vehicle

Cd : Drag Coefficient

A : Frontal Area

The value of Drag Coefficient depends on the streamline pattern of the vehicle. Cd value cannot be changes later on. So, depending on requirement this becomes a critical factor while designing an Electric Vehicle.

Figure 2 shows the graph of Streamline Vs Drag coefficient, where Cd value is declined as more streamlining is done. Cd value usually ranges from 0.3 to 0.35 in Cars, 0.33 to 0.35 in Vans and 0.42 to 0.46 in Pickup trucks.

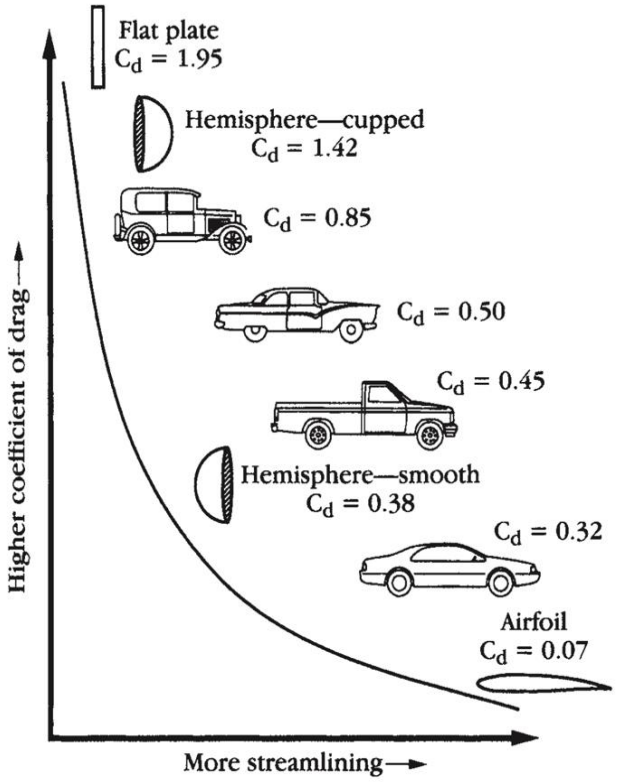


**Fig -2**: Graph of Streamline Vs Drag coefficient

### 4.3 HILL CLIMBING FORCE

The Hill Climbing force is the effort required to overcome the force of gravity on a slope due to the total mass of the vehicle and the gravitational pull. Zero if there is no tendency.

Hill climbing force is given by:

**FHC = MT x G x Sinθ**

FHC: Hill Climbing Force

MT : Total Mass of Vehicle

G : Gravitational pull

θ : Angle of Inclination

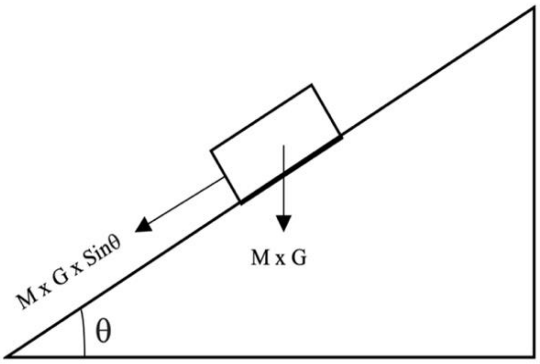


**Fig -3**: Free body diagram of an Electric Vehicle moving in Gradient/Inclined Road.

### 5. MOTOR RATING

Selection of motor plays a crucial role in designing an electric vehicle. Maximum speed required for the vehicle depends on the maximum power the selected motor can produce.

Motor Torque can be calculated as:

$$\text{Motor Torque} = \frac{\text{Total Tractive force x Radius of wheel}}{\text{Motor Efficiency x Gear ratio}}$$

By calculating the Maximum amount of torque required we can select the Motor of desired rating where this maximum torque should be in range. From the formula above motor torque is directly proportional to the total tractive force. This makes the car's rating based on rolling resistance, wind turbine and hill climbing power.

### 6. PROGRAMMING ALGORITHM

- ⇒ Start the program.
- ⇒ Import Π and Sin from math library.
- ⇒ Set the value of G.
- ⇒ Ask the user to enter the parameters as per their required design.
- ⇒ Perform the required calculations as per the given parameters.
- ⇒ Display the calculated value of Total
- ⇒ Tractive Force.
- ⇒ Take the confirmation from the user to proceed forward.
- ⇒ If user wants to proceed calculate the final motor rating and display the value on screen.
- ⇒ If user wants to change parameters go to step
- ⇒ 4 and continue again.
- ⇒ End the program after displaying the motor rating to the user.

### 7. CONCLUSION

Motor is known as the heart of an Electric Vehicle. The central purpose of this paper is to bring detailed information about the calculation of Motor rating using python, which can save the time put in for the calculations while designing an Electric Vehicle. For the calculations to be done through this program does not require high knowledge, a person with basic knowledge of inputting the data can get to know the desired Motor rating for the specified parameters of Electric Vehicle. This improves the flexibility of calculation of motor rating and more number of users can easily access. As the program is programmed used python the person with basic English proficiency can easily understand the program as python programming is not complex like c, c++, java etc., rather than deals with basic English.

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