Drive cycle analysis

**Task:**

**To find the desired torque vs. speed characteristics of a motor to be used in Activa Scooter.**

The drive cycle , “MONDAY MORNING” Data, which is collected in route between IIT GUWAHATI AND GUWAHATI CITY using “GPS speed graph PLUS” on Activa 6G. The drive cycle obtained is to be studied and relevant parameters for alternate electric vehicle option are to be evaluated.

First of all, the input data in arranged in excel sheet with velocity in kmph.

The vehicle data which will be used in further evaluation is tabulated here.

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| --- | --- | --- |
| Sr No | Parameter | Value |
| 1 | Total mass (Mass of vehicle + mass of rider) | 185 |
| 2 | Coefficient of rolling resistance (fr) | 0.004 |
| 3 | Air density (rho) | 9.81 |
| 4 | Aerodynamic drag coefficient of Vehicle (Cd) | 0.6 |
| 5 | Frontal area of vehicle | 0.8 |
| 6 | Road angle, alpha (degree) | 0 |
| 7 | Radius of wheel, r ( in m ) | 0.217 |
| 8 | Gear ratio | 1 |
| 9 | Transmission efficiency | 0.93 |
|  |  |  |

The weight here also includes the weight of rider.

The longitudinal forces to be considered are:

1. Force due to rolling resistance, Fr

Fr = fr \* m \* g \* cos(alpha)

= 7.2594 N

1. Force due to Aerodynamic Drag, Fd

Fd = 0.5 \* rho \* Af \* Cd \* V^2

1. Force due to Grading Resistance, Fg

Fg = m \* g \* sin(alpha)

1. Force due to acceleration, Fa

Fa = m \* a

From this at each point the maximum value of force required is estimated and from the speed of vehicle we get the RPM of the wheel. Assuming gear ratio and from the torque obtained from the Total force we get the power required at each point of time.

The drive data plot of torque vs RPM of all these actual points is,

Now the motor should be such that the torque-speed curve of motor should have least no of points above it when plotted to same scale.

Looking at the power requirement from the power required obtained from drive data we do some iterations to see what motor parameters satisfy above stated condition.

And the points which remain above this line can be neglected since to achieve this torque motor can be overloaded which is not advised to be done frequently.

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|  |  |  |  |
| --- | --- | --- | --- |
| **Iteration** | **Motor Constant power (W)** | **Motor base speed (RPM)** | **Constant torque**  **(Nm)** |
| 1 | 1500 | 300 | 47.74 |
| 2 | 1500 | 400 | 35.80 |
| 3 | 1800 | 300 | 57.29 |

The respective plots of drive data (torque vs RPM)

Chart, scatter chart

Description automatically generated

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As we can see from above plots, 1.5kW motor with both the speeds leaves several points above its characteristic curve. To minimize these points, let's increase the motor power to 1.8kW and see the effects.

Chart, scatter chart

Description automatically generated