Motor and Battery Selection

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Electric Subsystem
Jibebe

Overview

This report focuses on the comparison of different batteries choices and the recommendation of one of the batteries for use in the final implementation.

Goals

1. Compare different batteries based on several criteria
2. Recommend battery choice based on project requirements
3. Select the motor required for use based on different criteria

A.Motor Selection

Specifications

The top speed for the tricycle was chosen as 16km/hr. Converting to m/s

$$16\ x\ \frac{5}{18} = 4.4444\ \approx 4.5m/s$$

A design consideration is made such that the tricycle accelerates from rest to top speed in 9s. The acceleration of the tricycle is therefore:

$$a = \frac{v-u}{t}$$

$$a = \frac{4.5-0}{9} = 0.5\ m/s^2$$

The above calculation assumes a linear distribution for the motor velocity and a uniform distribution for the motor acceleration for simplicity.

The estimated mass of the tricycle is as follows

ITEM	MASS [kg]
Passenger	100
Carry Size	20
Chassis	50
Battery	60
TOTAL	220

By definition, work done is the change in kinetic energy. Therefore, the work done to accelerate the tricycle from 4.0m/s to 4.5m/s is:

$$Work\ done = \Delta KE = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$Work\ done = \frac{1}{2}\ x\ 220\ x\ 4.5^2 - \frac{1}{2}\ x\ 220\ x\ 4^2$$

$$Work\ done = \frac{1}{2}\ x\ 220\ x\ 4.5^2 - \frac{1}{2}\ x\ 220\ x\ 4^2$$

$$Work\ done = 467.5\ J$$

$$Power = \frac{Work\ done}{Time\ taken}$$

$$Time\ taken(t) = \frac{v-u}{a}$$

$$Time\ taken(t) = \frac{4.5-4}{0.5}$$

$$t = \frac{0.5}{0.5} = 1s$$

$$Power = \frac{467.5\ J}{1s} = 467.5\ W$$

The tricycle motor should therefore be rated for a power of 500W. An allowance of 100W-300W was considered to cater for motion on an inclined surface. The motor should therefore be sized between 600W-800W

B. Battery Selection

Electric:

Motor: BLDC

Voltage rating of motor: 48V

The power rating of motor: 500W

Desired Running time: 2 Hours

State of charge: 40 %

Calculations

I. Required AH

I. Current being drawn by the motor is calculated below

V * AH /1000 = Motor Capacity(in KW)

Here voltage of the motor is 48V

Motor capacity = 500W

So by equating these values 500/48 = 10.4

We get AH is 10.4

Ii. Acceleration current

While accelerating motor draws more current and in deceleration draws less. So in this condition, some current loss will be there and we take that loss as acceleration current. Here we take it as 5% (you can use a 5 -10% range if your vehicle runs in heavy traffic/ or the speed of the vehicle varies continuously)

So by considering acceleration current, the effective current drawn by the motor is:

10.4 * 1.05 = 10.92 A

II. Running time

We would like to have a running time of 2 hours thus required Ah is 10.92 * 2 = 21.84

III. Battery and Motor Efficiency

Then we need to consider the Efficiency of the battery pack.

Batteries usually have around 85% - 93% charging and discharging efficiency. Considering the worst case, let us take the efficiency of the battery pack as 85%.

So, Charge/ Discharge efficiency of the battery = 85%

Finally, we need to consider the Efficiency of BLDC Motor and usually, it is around 85 - 90%. Here we consider the worst-case efficiency taking 85%.

So the required Ah is 21.84 / (0.85 * 0.85) = 30. Ah

IV. State of Charge

We desire our state of charge to be at 40% . Thus the depth of discharge is 60 %.

Required Ah is 54.49 / (100/60) = 50.33Ah

Thus final requirements: **Voltage: 48V Current: 50.33Ah**

Comparison of different options of achieving the above

TO DO: ELIAS