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Conversion of Hydrocarbon Fueled Based Mini Hand Tractor into Electric Based Hand Mini Tractor

Er. Subhash Gautam[1], Aryan Dubey[2]
[1]*Associated Professor of Agricultural Engineering, JNKVV, Jabalpur*
[2]*UG Student, College of Agricultural Engineering, JNKVV, Jabalpur*

***Abstract:** Electric vehicles are a promising technology for achieving a sustainable transport sector in the future, because of their wonderful advantages like very low or zero-carbon emission, low noise and high efficiency. It also helps to decrease air pollution. Also, the electricity they consume can be generated from a wide range of sources, including fossil fuels, nuclear power and renewables such as solar power and wind power or any combination of those.[1]*

I. INTRODUCTION

The old vehicles with fuel based engines like petrol engines or diesel engines very costly and also produce pollution to the environment. But, in 1830s, American inventor William Morrison introduced the concept of electrical vehicles for the first time and it is not accepted at that time due to lack of convenience and high cost of making with comparison to hydrocarbon-fueled vehicles.
At the beginning of 21th century, interest in electric and alternative fuel vehicles increased due to growing concern over the problems associated with hydrocarbon-fuel vehicles. Most early electric vehicles were massive, ornate carriage designed for upper-class customers that made them popular. They featured luxurious interiors and were replete with expensive materials.[2]
California electric car maker Tesla Motors began development in 2004 on Tesla Roadster, which was first delivered to customers in 2008. The Roadster was the first highway legal serial production all electric car to travel more than 320 km (200 miles) per charge. Since 2008, Tesla sold approximately 2,450 Roadster in over 30 countries through December 2012. Today, electric vehicles are used widely in all over the world, but yet they are not get advancement in commercial sector or in agriculture sector.[3][4]

II. AIM & OBJECTIVE

The aim of the research project is to convert the traditional hand operated mini tractor into electric mini tractor. Since, traditional mini tractor are working on hydrocarbon fueled engine which produces high torque to work in agriculture fields. So, in this research project we will replace the hydrocarbon fueled engine with an electric motor and also make proper arrangement to give sufficient power to the tractor by which it can work on agriculture field. We will specifically transform an hand operated mini tractor with cultivator attached on it into electric mini tractor.[5]

A. Modelling

1) Calculation

Dimensions of our vehicles
Width = 85 cm
Height = 95 cm
Mass = 220 kg (expected with equipment)
Average speed on field = 10 km/hr (after adding gear box)

There are two main forces we consider on our tractor are-

a) Rolling resistance
b) Drag force
c) Force exerted by equipment (cultivator)

2) *Rolling resistance (F_r)*

$$F_r = C_{rr}N$$

where,

C_{rr} = rolling resistance coefficient (0.05 for soil)
N = normal force (m×g)
$F_r = 0.05 \times 220 \times 9.81$
$F_r = 107.91$ N

3) *Drag force (F_d)*

$$F_d = C_d A p v^2/2$$

where,

C_d = drag coefficient (0.6 experimentally determined)
A = cross sectional area (0.95×0.85)
P = density of fluid (1.2 kg/m^3 for air at NTP)
V = speed of the object relative to the fluid
$F_d = 0.6 \times 0.8 \times 1.2 \times (2.8)^2/2$
$F_d = 2.25792$
$F_d = 2.25$ N (approx.)

4) *Force Exerted by Equipment (cultivator)*

Force exerted by one teeth of cultivator = 30 N (practically found)

So ,

Force exerted by our cultivator (F_e) = $N_t \times 30$

where,

N_t = no. of teeth in cultivator (5)

$F_e = 5 \times 30$
$F_e = 150$ N

5) *Total force (F_t)*

$$F_t = F_r + F_d + F_e$$
$F_t = 107.91 + 2.25 + 150$
$F_t = 260.16$ N

6) *Power (P)*

$$P = (F_t \times v)/n$$

where,

F_t = total force
v = speed of the object relative to the fluid
n = efficiency (0.85 motor efficiency)

$P = (260.16 \times 2.8)/0.85$
$P = 856.99$W

7) *Wheel RPM*

Circumference of wheels = $2\pi r$
$C_w = 2 \times 3.14 \times 0.25$
$C_w = 1.57$ m
Speed (we want) = 10 km/hr
S = 10000/60 m/min
S = 166.66 m/min
Wheel RPM = 166.66/1.57
RPM = 106 RPM

8) Gear Ratio

A gear ratio is a ratio of the number of rotation of a driven gear (input) to the number of rotation of driving gear (output).[6]

$$\text{Gear ratio} = {}^{\text{no. of rotation of driven}}/_{\text{no. of rotation of driving}}$$

So,

we are using no. of pair of gear in order to maximize the torque and control speed in according to requirement.

Since,

The gear ratio we are using in our research project is 25:1.

9) Motor

We need a power of 856.99W.

So,

According to market availability, we will select of 1000W (1kw) motor.

$$P = 1000W$$

$$\text{Motor RPM} = \text{gear ratio} \times \text{wheel RPM}$$

$$\text{Motor RPM} = 25 \times 106$$

$$\text{Motor RPM} = 2650 \text{ RPM}$$

$$\text{Torque (N.m)} = 9.5488 \times \text{power(W)/speed (RPM)}$$

$$\text{Torque} = 9.5488 \times 856.99/2650$$

$$\text{Torque} = 3.08\text{N.m}$$

Now, we have to select a motor with power of 1000W, torque of 3.08N.m and RPM of 2650.

10) Battery

Current consumed by motor to run

$$\text{Current} = {}^{\text{power}}/_{\text{voltage}}$$

$$\text{Battery voltage} = 48V$$

$$\text{Current} = {}^{1000}/_{48}$$

$$\text{Current} = 20.84 \text{ Ampere(A)}$$

To run 1000W motor for 2hr

$$= 1000 \times 2 \times \text{efficiency}$$

$$\text{Assumed battery efficiency} = 80\%$$

$$= 2500\text{Watt hour}$$

Current(I) in ampere hour require in battery

$$\text{Power hour} = \text{voltage} \times \text{ampere hour}$$

$$2500 = 48 \times I$$

$$I = 52\text{Ah}$$

So, we need a battery of 48 volt and of 52 ampere hour from which we can drawn 21 ampere (approx.) to run tractor for 2 hr.

11) Final Assembly

After selection of motor and battery we have to put them inside our tractor in such a way, where the force management of it remains constant. So, we replace the hydrocarbon-fueled engine with our BLDC motor and fuel tank with our lithium-ion battery also the old gear box with our high gear ratio gear box.

III. ANALYSIS

In the analysis obtain that the average output torque is 77N.m, which is good enough to work our cultivator or other equipment in the fields. We got this torque from a motor with 3N.m torque with the help of gear box having high gear ratio. The formula of output torque after adding gear box is

$$\text{Output torque} = \text{gear ratio} \times \text{input torque}$$

IV. CONCLUSION

The conversion of traditional hydrocarbon-fueled engine mini tractor int electric mini tractor is simple and convenient. It is a good option for farmers to use electric mini tractor which will increase their worth and also cause less pollution then hydrocarbon-fueled based engines.

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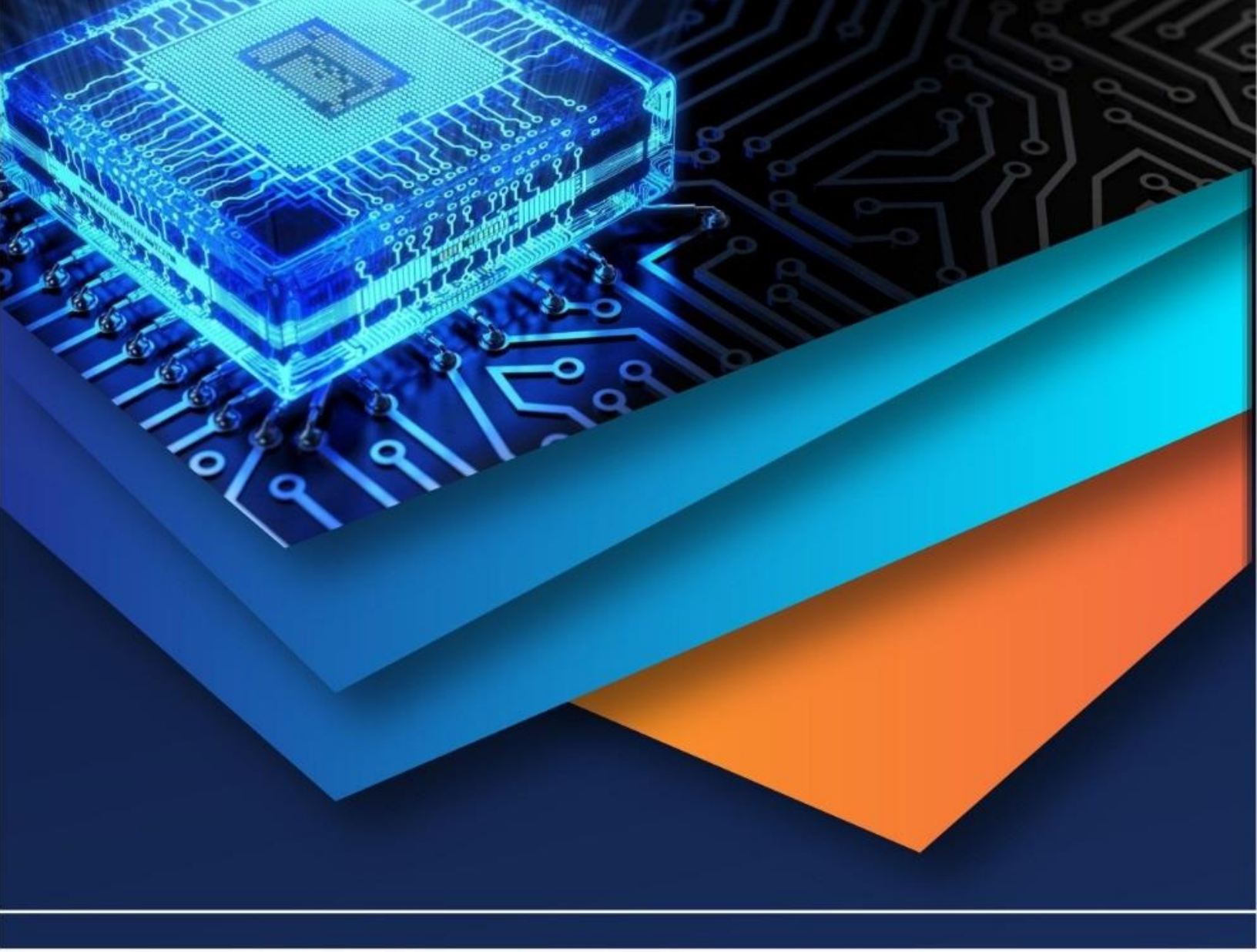

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