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FUEL CELL TECHNOLOGY FOR MONOWHEEL VEHICLE

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ABSTRACT: *Monowheel vehicles present a number of challenges to the designer and several compromises have to be made to get everything come together into a functional machine. Since the Fuel cell vehicle is any vehicle that uses a fuel cell to produce its on-board motive power, monowheel must also take into consideration this green energy. Fuel cells on board the FC hydrogen vehicles create electricity to power an electric motor using hydrogen fuel and oxygen from the air. A fuel cell process eliminates only water and heat.*
KEYWORDS: *monowheel vehicle, fuel cell vehicle, green energy.*

1. SUMMARY

It begins with good asset design; moving beyond designs that minimize initial construction costs, utilities must account for environmental, social, and economic factors, including energy efficiencies. By considering historical outage and efficiency rates, maintenance schedules, and expected length of life in the design process, utilities can use integrated design software to create more sustainable designs while ensuring asset longevity.
Model-driven design software can also improve sustainability during the design process. Leading utilities are turning to 3D design tools to dramatically reduce the costs of design work. With accurate models in place, utilities can produce contextual visualizations of the planned substation and develop a footprint with minimal environmental impact.
Increasingly, consumers are concerned about sustainable energy use, adding smart devices on appliances Consumers want to better control their usage – requiring timely data on peak loads and rates. To support these requests, utilities need access to accurate, as-built data so they can provide consumers with pertinent environmental and usage information and deliver customer services related to sustainability more efficiently.
The Monowheel recharge using electricity generated from the hydrogen and presents a truly decarbonised living and transport system that does not rely on an alternative fuel infrastructure. The ability to manage every aspect of the asset life cycle plays a role in going green. A wheel which spins in two planes and is set to challenge, perhaps even change, society's concept of personal mobility.

2. TYPES OF ELECTRIC VEHICLE IN USE TODAY

There are effectively six basic types of electric vehicle, which may be classed as follows. Firstly there is the traditional battery electric vehicle, which is the type that usually springs to mind when people think of electric vehicles. However, the second type, the hybrid electric vehicle, which combines a battery and an IC engine, is very likely to become the most common type in the years ahead. Thirdly there are vehicles which use replaceable fuel as the source of energy using either fuel cells or metal air batteries. Fourthly there are vehicles supplied by power lines. Fifthly there are electric vehicles which use energy directly from solar radiation. Sixthly there are vehicles that store energy by alternative means such as flywheels or super capacitors, which are nearly always hybrids using some other source of power as well.
Fuel cells are electrochemical devices that convert the chemical energy of a reaction directly into electrical energy. The basic physical structure or building block of a fuel cell consists of an electrolyte layer in contact with a porous anode and cathode on either side. A schematic representation of a fuel cell with the reactant/product gases and the ion conduction flow directions through the cell is shown in Figure 1.

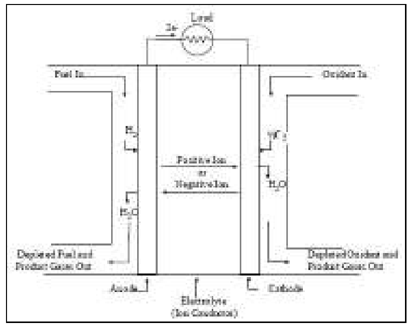

Figure 1: Fuel Cell

The need for urgent action on global warming has seen large amounts of money allocated to R&D for environmentally sustainable transport and we're beginning to see a range of new and very different form factors.

3.ELECTRIC VEHICLE MODELLING

The simulation of performance, by which we usually mean acceleration, is fairly straightforward. Mathematical software such as MATLAB suits itself very well to this. In the case of the classical battery powered electric vehicle, and fuel cell vehicles using stored hydrogen, the modelling of range, though considerably more complex, is not difficult. For hybrid vehicles a great deal of care and thought is needed in setting up a simulation.

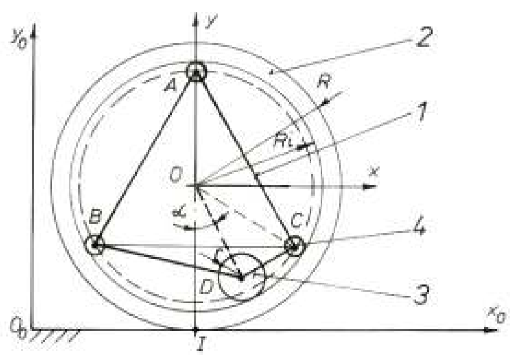

Figure 2: Simplified model

3.1. Introduction:

With all vehicles the prediction of performance and range is important. Computers allow us to do this reasonably easily. Above all, computer based methods allow us to quickly experiment with aspects of the vehicle, such as motor power, battery type and size, weight and so on, and see how the changes affect the performance and range. The parameter we shall model is vehicle's acceleration.

3.2. Vehicle acceleration

If the velocity of the vehicle is changing, then clearly a force will need to be applied in addition to the now present forces. This force will provide the *linear acceleration* of the vehicle, and is given by the well-known equation derived from Newton's second law, $F = ma$.

However, for a more accurate picture of the force needed to accelerate the vehicle we should also consider the force needed to make the rotating parts turn faster. In other words, we need to consider *rotational* acceleration as well as *linear* acceleration.

Referring to Fig. 3, we shall denote by *r* the radius of the driving wheel, and by F_{te} the propulsive effort delivered by the power train to the rim. If "i" is the gear ratio of the system connecting the motor to the axle of the driving wheel, and M_m is the motor torque, then we can say that:

$$M_m = \frac{F_{te}\, r}{i} \tag{1}$$

$$F_{te} = \frac{M_m}{r} i \quad (2)$$

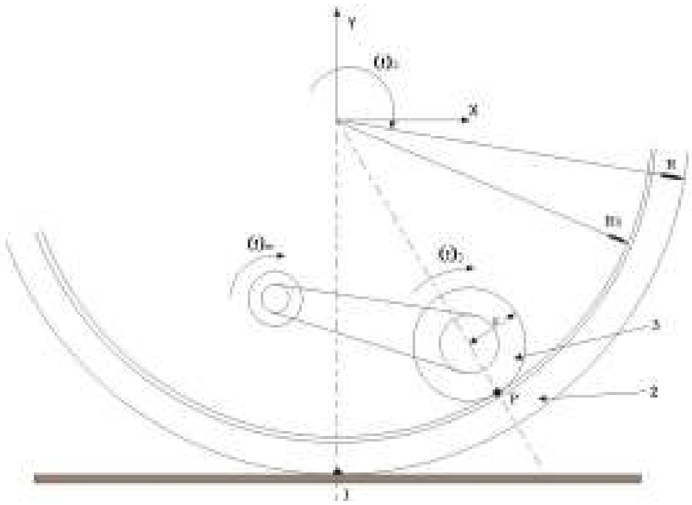

Figure 3: Detailed analisys

We should also note that $\omega_2 = \frac{v}{R}$. The motion is transmitted between wheels 2 and 3 without slipping, so we shall have the relation:

$$R_i \omega_2 = r\omega_3$$

(3)

The transmission between engine and driving wheel 3 having the ratio "*i*", we can write the motor angular speed:

$$\omega_m = iv\frac{R_i}{rR} \quad (4)$$

and, consequently, the motor angular acceleration as:

$$\varepsilon_m = ia\frac{R_i}{rR} \quad (5)$$

On the other hand, the reduced inertia moment of the system will be:

$$J_{red} = J_m + J_3\left(\frac{\omega_3}{\omega_m}\right)^2 + J_2\left(\frac{\omega_2}{\omega_m}\right)^2 + M\left(\frac{v}{\omega_m}\right)^2$$

(6)

Then, the motor torque M_m is:

$$M_m = J_{red}\,\varepsilon_m \quad (7)$$

3.3. Electric vehicle acceleration modelling:

Here can be found MATLAB script for the modeling of acceleration, where the driving wheel is called "driwhl":

```
% Simulation. This simulation is
% for acceleration measurement. The run continues until
% the battery depth of discharge > 90%
```

```
ECE 47; % Get the velocity values, they are in
% an array V, and in m/sec.
N=length(V); % Find out how many readings
% First we set up the vehicle data.
mass = 185 ; % Driwhl + one 70 kg passenger.
area = 0.6; % Frontal area in square metres
Cd = 0.75; % Drag coefficient
Gratio = 2/0.21; % Gearing ratio, = G/r
G eff = 0.97; % Transmission efficiency
Regen ratio = 0.5; %This sets the proportion of the
% braking that is done regeneratively
% using the motor.
bat type='NC'; % NiCAD battery.
NoCells=15; % 3 of 5 cell (6 Volt) batteries.
Capacity=100; % 100 Ah batteries. This is
% assumed to be the 5 hour rate capacity
k=1.05; % Peukert coefficient, typical for NiCad.
Pac=50; % Average power of accessories.
kc=1.5; % For copper losses
ki=0.1; % For iron losses
kw=0.00001; % For windage losses
ConL=20; % For constant motor losses
% Some constants which are calculated.
Frr=0.007 * mass * 9.8; % Equation 7.1
Rin = (0.06/Capacity)*NoCells; % Int. resistance, Equ. 2.2
Rin = Rin + 0.004; %Increase int. resistance to allow for
% the connecting cables.
PeuCap = ((Capacity/5)^k)*5 % See equation 2.12
% Set up arrays for storing data for battery,
% and distance traveled. All set to zero at start.
% These first arrays are for storing the values at
% the end of each cycle.
% We shall assume that no more than 100 of any cycle is
% completed. (If there are, an error message will be
% displayed, and we can adjust this number.)
DoD end = zeros(1,100);
CR end = zeros(1,100);
D end = zeros(1,100);
% We now need similar arrays for use within each cycle.
DoD=zeros(1,N); % Depth of discharge, as in Chap. 2
CR=zeros(1,N); % Charge removed from battery, Peukert
% corrected, as in Chap 2.
D=zeros(1,N); % Record of distance traveled in km.
XDATA=zeros(1,N);
YDATA=zeros(1,N);
CY=1;
% CY controls the outer loop, and counts the number
% of cycles completed. We want to keep cycling till the
% battery is flat. This we define as being more than
% 90% discharged. That is, DoD end > 0.9
% We also use the variable XX to monitor the discharge,
% and to stop the loop going too far.
DD=0; % Initially zero.
while DD < 0.9
%Beginning of a cycle.************
one cycle;
% **********
% Now update the end of cycle values.
DoD end(CY) = DoD(N);
CR end(CY) = CR(N);
D end(CY) = D(N);
% Now reset the values of these "inner" arrays
% ready for the next cycle. They should start
```

```
% where they left off.
DoD(1)=DoD(N); CR(1)=CR(N);D(1)=D(N);
DD=DoD end(CY) % Update state of discharge
%END OF ONE CYCLE ***************
CY = CY +1;
end;
plot(XDATA,YDATA,'k+');
```

4. CONCLUSION

This project even if it's a recreational one for the moment, it might be the subject of a future terrestrial transportation way, smaller and less polluting. With new materials and technologies, beginning to catch up with science fiction, it might be an army of young designers unrestrained by old thinking, to concept personal transport vehicles which seems to evolve into forms that we have hardly before imagined.

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