

Simulation Approach to Analyse the Performance of SRM Hub Motor for Electrical Vehicle

Prasobh P^[1], Sindhu V^[2]

PG Student, Sree Buddha College of Engineering, Pattoor, Alappuzha, Kerala, India¹

Assistant Professor, Sree Buddha College of Engineering, Pattoor, Alappuzha, Kerala, India²

ABSTRACT: Automobile industry is a developing sector. Many advanced technologies are implementing in this field. In current situation for pollution control, conventional diesel vehicles are replacing with new eco friendly Green vehicles. Thus electric vehicles have their on importance in current situation. Thus new and enhanced technologies are needed for improving the performance of conventional electric vehicles. This paper is trying to analyse a new model of SRM Hub motor for electrical vehicle. For vehicle modeling Passive loading scheme is used.

KEYWORDS: Electric vehicle, Hub- SRM, MATLAB, Simulation, SRM, Switched Reluctance Motor.

I. INTRODUCTION

In modern society, automobile plays a vital role. An automobile driven by an internal Combustion Engine (ICE) which runs on fossil fuel is a major achievement of the present technology. As fossil fuel being exhausting it has produced threats to the usage of internal combustion engine (ICE) vehicle. Therefore, the present research in the automobile industry is concentrated to design the electric transportation system for providing eco friendly and smart alternative. Electrical Vehicles are the best alternative to the traditional vehicle driven by IC engines in the era of green technology.

In context of electric drive switched reluctance motor shows significant advantages. Because of its simple mechanical construction, low manufacturing cost, efficiency, torque-speed characteristics, and very low maintenance make it natural choice for integration in to electrical vehicle. In this paper SRM Hub-motor system for driving electrical vehicle is presented. For analyzing its performance Passive loading scheme is used.

II. SWITCHED RELUCTANCE MOTOR

The switched reluctance motor (SRM) works on the principle of reluctance torque. The SRM have wound field coils on the stator only. The rotor has neither magnets nor coils attached in it. In SRM torque is generated by the affinity of the rotor to move to a point where the inductance of the excited winding is extreme or reluctance is lowest. The magnetic reluctance of the rotor creates a force whenever the stator windings are energized, which helps to align the rotor pole with the nearest stator pole. To maintain the rotation a proper electronic control system is needed. It switches on the windings of stator poles in appropriate sequence in such a way that the magnetic field of the stator leads the rotor pole results in drawing it forward.

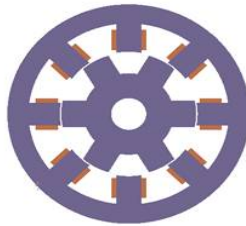


Fig. 1 SRM

III. TORQUE - SPEED CHARACTERISTICS

Before employing this machine to the electrical vehicle, we have to check whether it fulfills the Torque speed requirements for an electrical vehicle. For an electrical vehicle, in the initial starting time, the torque is higher and speed is lower and when the speed become higher, the torque comes to a lower value.

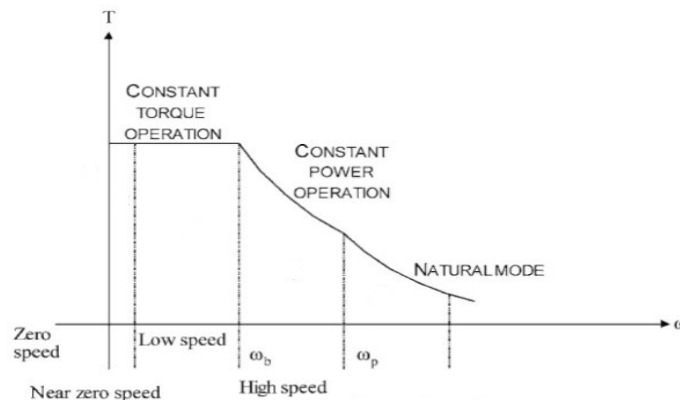


Fig. 2 SRM Characteristics

By analyzing the Torque-speed characteristics of an SRM, it will match with the essential requirements of the electrical vehicle. At lower speeds it is showing a higher torque. While decreasing the torque, the speed is increasing. So the conditions are satisfied.

IV. ELECTRICAL VEHICLE MODELING

The mathematical model of electrical vehicle with two equally sized wheels, moving forward or backward along its longitudinal axis is developed. Assumed that vehicle is in the vertically stable state thus wheels are always perpendicular to the horizontal plane.

Vehicle parameters are as follows:

'm' is a mass of the vehicle in (kg) = 200

'a' is a horizontal distance of CG from front axis in (m) = 1.4

'b' is a horizontal distance of CG from rear axis in (m) = 1.6 'h' is a height of CG from the ground in (m) = 0.5

'A' is a front area in (m²) = 1.2 'Cd' is a drag co-efficient = 0.4

'V_x' is a longitudinal velocity of the vehicle in (m/s) 'ρ' is a mass density of air in (Kg/m³) = 1.2

'F_D' is an aerodynamic drag force in (N)

'F_{XF}' is a longitudinal force applied at the front wheel in (N)

'F_{XR}' is a longitudinal force applied at the rear wheel in (N)

'r' is a radius of the wheel in (m) = .279

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

In the model the output of the vehicle is with the longitudinal velocity of the vehicle with the input longitudinal force applied to the front and rear wheels. Assuming that the rear wheel drives require longitudinal force at the rear wheel to accelerate the vehicle with the velocity V_x is, where

$$F_x = m \frac{dV_x}{dt} - F_d + mg \sin(\beta) \quad (1)$$

$$m \frac{dV_x}{dt} = F_x + F_d - mg \sin(\beta) \quad (2)$$

Aerodynamic drag force,

$$F_d = -\frac{1}{2} C_d \rho V_x^2 \text{sgn}(V_x) \quad (3)$$

From the (2) and (3) dynamic model of the vehicle system is simulated in the MATLAB Simulink environment as shown in Fig. 3 and Fig. 4

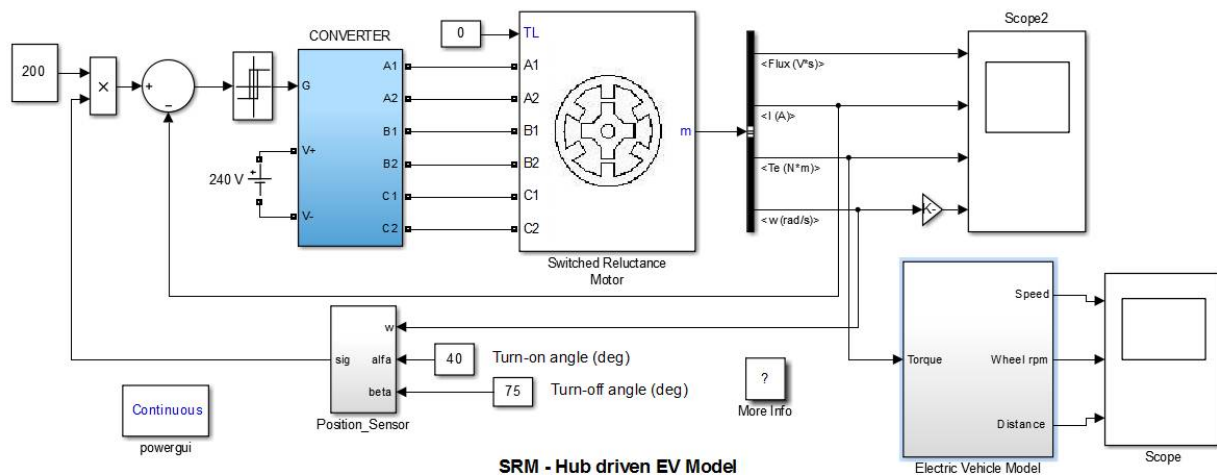


Fig. 3 SRM – Hub driven EV Model

Fig. 3 Shows the MATLAB model of SRM –Hub driven electrical vehicle is shown above. In the electrical vehicle block vehicle modelling is inserted. Conventional SRM model is used to realize the driver motor. A position sensor is used to detect the position of the rotor.

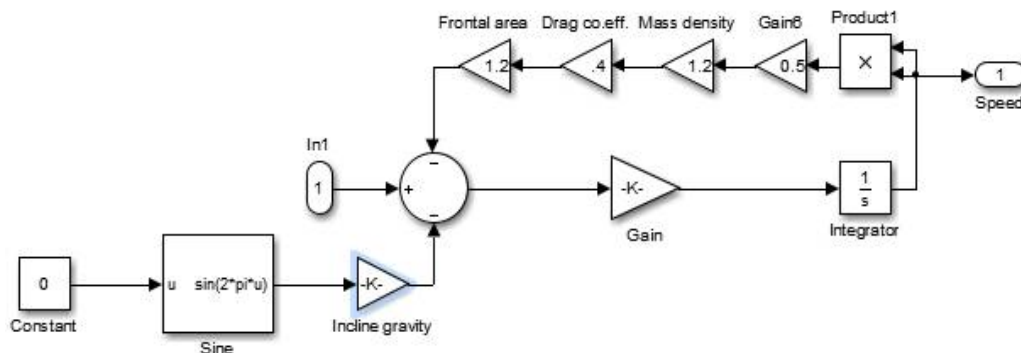


Fig 4. Electric Vehicle Model

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

Electrical vehicle modelling using the above equations are realized using MATLAB. Partial loading scheme is used to realize the electrical vehicle model.

V. SIMULATION RESULT

Simulation results for the in-wheel SRM electric vehicle system proposed are as shown below. It shows that speed of the SRM and that of the vehicle is almost same at any instant and thus validate the proposed method to simulate the Hub driven SRM electric vehicle system.

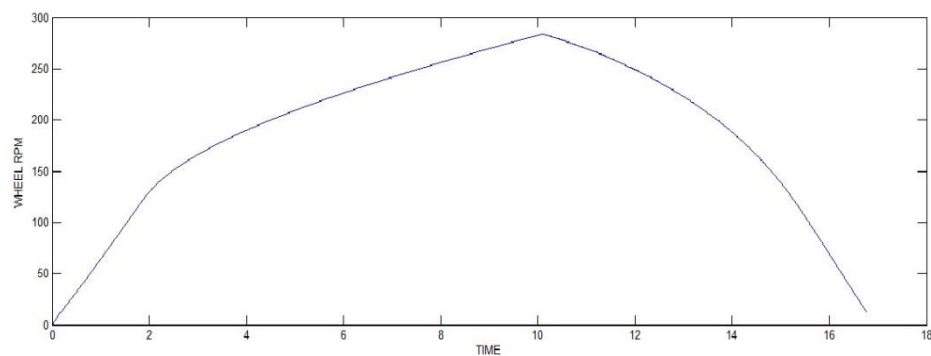


Fig 6. Wheel RPM – Time graph

From the figure it is clear that the Speed(Wheel RPM) – Time graph is suitable for electrical vehicle operation. In the initial portion the graph is linear because the stationary inertia is very high in this region. After that the speed increases very smoothly. After 10 second the brake is applied so the speed is decreases.

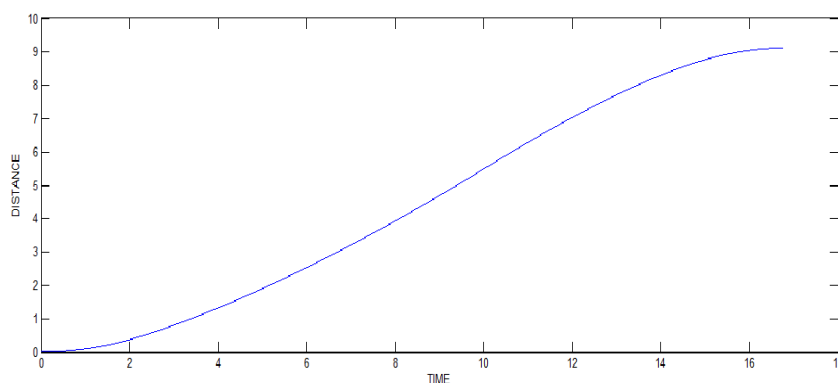


Fig 7. Distance – Time graph

The Distance – Time graph is very close to the linear graph so it is very suitable for EHV. The graphs obtained by simulating the above model are superior to that of internal combustion engine (ICE). So SRM-Hub driven vehicle shows superior characteristics compared to internal combustion engine in initial torque, running torque, acceleration etc.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 2, February 2017

VI. CONCLUSION

- The result indicate that suggested system can be used to analyses the performance and suitability of any electrical motor for driving electrical vehicle with the MATLAB Simulink environment.
- Its shows that that SRM is very suitable for Electrical vehicle application

REFERENCES

- [1] T. J. E. Miller, *Switched Reluctance Motors and their Control*. Oxford, U.K.: Oxford Science, 1993.
- [2] Krishnan, R., "Switched Reluctance Motor Drives: Modeling, Simulation, Analysis, Design, and Applications", CRC Press, 2001.
- [3] Shyam S. Ramamurthy and Juan Carlos Balda "Sizing a Switched Reluctance Motor for Electric Vehicles" *IEEE Transaction on industrial electronics*, vol. 37.
- [4] P. C. Kjaer, J. Gribble, and T. J. E. Miller, "High-grade Control of Switched Reluctance Machines," *IEEE Trans. Industry Electronics*, Vol. 33, pp. 1585–1593, Nov. 1997.
- [5] Changhwan Choi, Seungho Kim, Yongdae Kim and Kyihwan Park, "A New Torque Control Method of a Switched Reluctance Motor Using a Torque-sharing Function", *IEEE Transactions on Magnetics*, vol. 38, no. 51, pp. 3288-3290, 2002
- [6] Krzysztof Russa, Iqbal Husain and Malik E. Elbuluk, "Torque Ripple Minimization in Switched Reluctance Machines over a Wide Speed Range", *IEEE Transactions on Industry Applications*, vol. 34, no. 5, pp. 1105 1112, 1998
- [7] Centa, G., *Motor Vehicle Dynamics: Modeling and Simulation*, Singapore, World Scientific, 1997.
- [8] Pacejka, H. B., *Tire and Vehicle Dynamics*, Society of Automotive Engineers and Butterworth-Heinemann, Oxford, 2002.
- [9] Lawrenson, P.J., and AGU, L. A.: „Theory and performance of polyphase reluctance machines“, *IEE Proc. B, Electr. Power Appl.*, 1964,111, pp. 1435-1445
- [10] Lawrenson, P.J., Stephenson, J.M., Blenkinsop, P.T., Corda, J., and Fulton, N.N. „Variable-speed switched reluctance motors“, *IEEE Proc.*, 1980, Vol.127, Pt.B.No (4), pp. 253-265
- [11] Kwon, Y.A. "Computation of Optimal Excitation of a Switched Reluctance Motor Using Variable Voltage." *IEEE Transactions on Power Electronics*, vol. 45, No. 1, (February 1998). pp.177-180.
- [12] Acarnley, P. P. *Stepping Motors: A Guide to Theory and Practice*. 4th ed. London: Institution of Electrical Engineers, 2002. Print.