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Propeller Load Characteristic Pmsm Vector Control System Simulation Based

Dr. R.Venkatasubramanian*[1],Dr.A.V.G.A.Marthanda[2], Dr.J.Karthika[3], M. Devika Rani [4] ,Dr.S.JaanaaRubavathy[5], R.Venkatesh[6]
[1]Associate Professor, Dept of EEE, Jeppiaar SRR Engineering College, India
[2]Associate Professor, Dept of EEE, LakireddyBalireddy College of Engineering, India
[3]Associate Professor, Dept of EEE, Sri Krishna College of Engineering and Technology, India.
[4]Assistant Professor, Dept of EEE, Prasad V Potluri Siddhartha Institute of Technology, India.
[5]Associate Professor, Dept of EEE, Saveetha School of Engineering, India
[6]Assistant Professor, Department of Physics, PSNA College of Engineering and Technology, India
*rvsmsri@gmail.com**

Abstract:- In this paper the vector control mechanisms for a variable PMSM electric motor force, 4088W, have been analyzed in this paper At the foundation of the PMSM and the concept of vector regulation, two techniques for predicting PMSM systems are laid: Current Hysters PWM (Pulse Width Modulation) and SVPWM (Space Vector). Then 4088W propeller-shaft speed output was checked. motor launch and SVM will minimize torque ripple

I. INTRODUCTION

In the recent history of permanent magnetic materials and control technologies, has permanent motor technology has been used for electric ship propulsion The PMSM have a few benefits, such as good power density and high [durability] [1] Direct torque regulation and vector control are two essential AC motor control strategies today. The DTC with PMSM for ship propulsion has been modelled. that affects broad rpms. EVPWM process as anis

1)Saturationis neglected
2)Eddycurrents and hysteresis effects are neglected
3)Balancedthree phase currents are assumed

Rotating reference frame (d-q) machine equations as follows: Stator voltage equations are:

$$u_{sd} = R_s i_{sd} + \frac{d\psi_{sd}}{dt} - \omega_r \psi_{sq} \qquad (1)$$

$$u_{sq} = R_s i_{sq} + \frac{d\psi_{sq}}{dt} + \omega_r \psi_{sd} \qquad (2)$$

.

Stator magnetic flux linkage equations are:

$$\psi_{sd} = L_d i_{sd} + \psi_f \qquad (3)$$

$$\psi_{sq} = L_q i_{sq} \qquad (4)$$

:

Electromagnetic torque equation is:

$$T_e = \frac{3}{2} n_p \left(\psi_{sd} i_q - \psi_{sq} i_d \right) \qquad (5)$$

Motor movementequation is:

$$T_e = T_L + B\frac{\omega_r}{n_p} + \frac{J}{n_p}\frac{d\omega_r}{dt} \qquad (6)$$

Where *usd,usq,isd,isq,Ld,Lq*are respectivelythe voltage, currentand inductance on d,q axis. *Rs*,,□ □,□□arethestator *rf*

Torque ripple has been reduced by a modern monitoring technique It is used to regulate the direction of the ship's propulsion engine. In paper of [4], we used the SVP method of simulation But in the simulation, the motor is not centered on the propeller characteristic the propeller showed up in 4088K PMSM regulation has been analyzed in this paper In motor simulation, the findings are compared with the methods of Current Hysters MPP and SVP

II.THEMATHEMATICA MODELOFPMSM

ThePMSMequations aredeveloped in rotating reference Frames, Assumptions in developing the mathematicalmodelresistance,electricangular speedandpermanentflux,respectively.T_e,T_L,B,$n_p$and$J$ representelectro-magnetic torque,loadtorque,viscousfrictioncoefficient,numberof pole pairs andtotalmomentinertia of rotorandload, respectively.

III.VECTOR CONTROLPRINCIPLE.OFPMSM

Fromthe equations of (3), (4) and (5) the electro-magnetic torque canbe expressed as:

$$T_e = \frac{3}{2} n_p \left(\psi_f i_{sq} + (L_d - L_q) i_{sd} i_{sq} \right) \qquad (7)$$

Thebasicideaofvectorcontrolisasfollows:through the coordinatetransformation,decomposethePMSMstatorcurrent *is* intotwo components field current component *isd*and its

verticaltorquecurrentcomponent*isq*.From theequation(7), whenthe *isd*= 0, theelectro-magnetictorque*Te*willbe:

$$T_e = \frac{3}{2} n_p \psi_f i_{sq} \qquad (8)$$

Sotherelationshipofelectromagnetictorque*Te*and*isq*islinear, inspeedregulatingprocess,aslong asmaintain thefieldcurrent component *isd*=0 and control the *isq*meanwhile, a good dynamiccharacteristicofthe*Te*canbeobtained

IV. HYSTERESISBAND CURRENT CONTROL PWM

hysteres bands feedback-forward current power The operation of the hysteres current is shown in Figure 4.8 the use of the current controller is to mimic the flow of the reference. The load current is measured and correlated with three H times by three hysteres current circuits having three hyste band amplifiers The comparator performance error currents are used to switch the inverter. B Based on band, there are two kinds of existing controllers: a fixed band hysteres model and a sinusoidal band hysteres model. we are focusing on constant band current

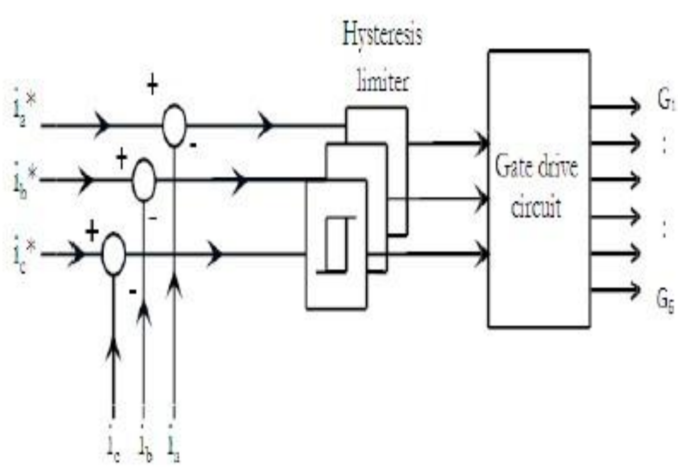

Fig1.Basiccircuitdiagramofhysteresiscontroller

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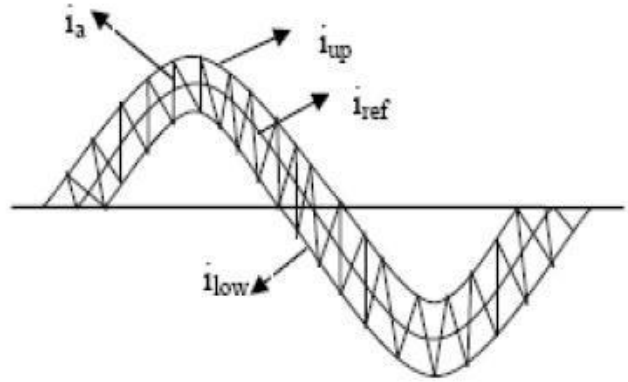

Fig2.Hysteresiscontrollercontrolstructure

Figure 2 shows the behavior of a fixed-band hysteres controller. The hysteres band is locked in place for the long term The fixed-band control formulas are:

Iref= ImaxSinwt

Iup= Iref+ H Ilo= Iref–H

where iup is the upper band, H is the hysteis limit If from equation 2, Ais equal to 0, such that the inversion reduces the line current even if NA > 1, such that the load current is increased

V. SPACE VECTOR PULSE WIDTH MODULATION (SVPWM)

It is an extremely productive way to create the six PWM outputs for two-stage level inverter implementation. Figure 3 shows the circuit model of a three-phase PWM inverter

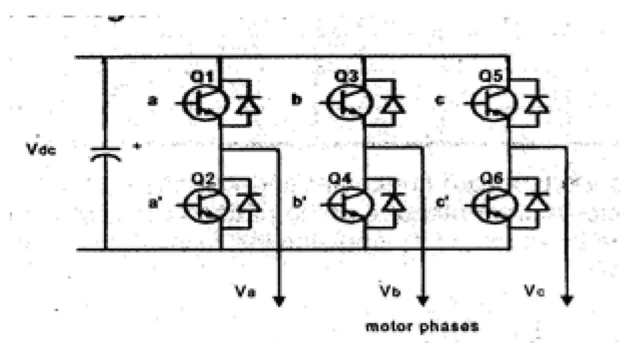

Fig3ThreephasevoltagesourcePWMinverter

TheSpacevector PWMcanbeimplemented by thefollowing steps:

Step1:DetermineV□,V□,V*,andangle(□) Step2:DeterminetimedurationT1,T2,T0.
Step3:DeterminetheswitchingtimeofeachTransistor.

VI. PROPELLERLOADCHARACTERISTIC

The face of the propeller is in the opposite direction to the rotation. To conquer the resistance, the resistance, the propeller must provide the moment; to transform at the correct rpm. According to the job theory of the work done by a propeller may be written as:

$$T_L = K_t \rho n^2 D_p^{\ 5} \qquad (9)$$

whereDp(m) is density, ρ(kg/m^3) and propeller speed as a feature of the advance ratio At the steady state while the ship is complete and at full pace in free-steer mode. Now, the APO and RPM are also equal. So, as a result, the load torque is

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equal to the square of the propeller rpm.

VII. SIMULATIONOFTHEVECTOR CONTROL MODELWITH THEPROPELLERLOAD

Two signal outputs are used, one is Current Hysteiis PWM and the other is the SVPWM The simulations are Figures 4 and 5

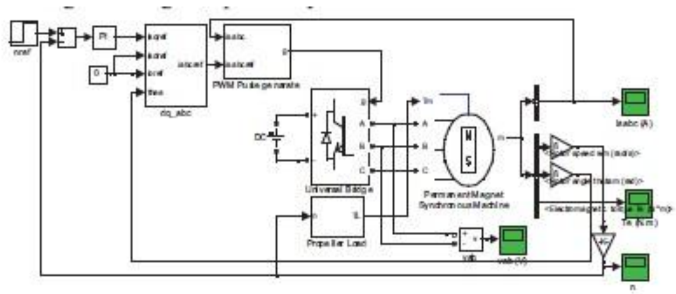
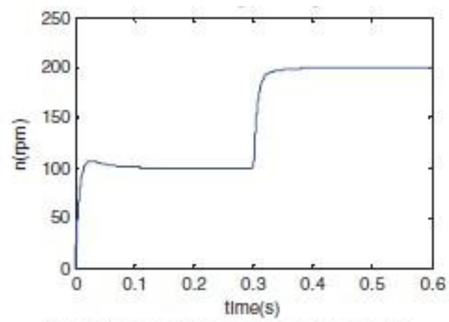
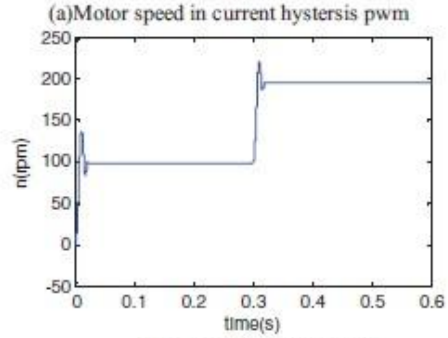


Fig.4.Simulationmodelofvectorcontrolsystem (currenthystersispwm)



(a)Motor speed in current hystersis pwm



(b) Motor speed in svpwm

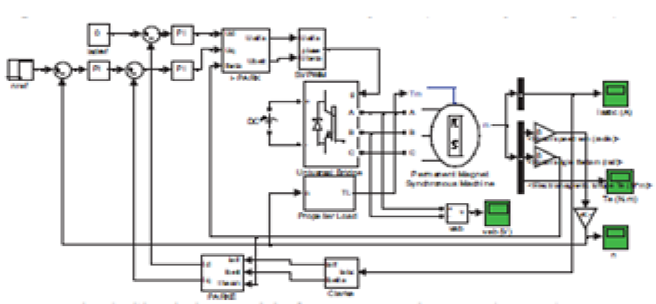


Fig. 5**.**Simulationmodelofvectorcontrolsystem(svpwm)

The parameters of thePMSM thatused in this simulation modelare:
Power rating:4088kW Rated voltage:660V
Rated current:4348A
Momentof inertia:2000kg·m2

Rated torque:195200N·m
Rated speed:200 r/min
In the equation (9):□□=1025kg/m3,*Dp*=3.6 m, when the speed of thePMSMreaching200 r/min, the speed of the propelleralso reached200 r/min, the electro-magnetic torque shouldbe equal to theload torque thatproduced by the propeller. So thetorque coefficient*Kt*canbe calculated

$$K_t = \frac{195200}{1025 \times \left(\frac{200}{60}\right)^2 \times 3.6^5} = 0.028$$

ThesimulationresultsareFig3Motorspeedincurrenthystersispwmandsvpwm
Fig.4.Motorelectromagnetic torque incurrenthystersispwm and svpwm

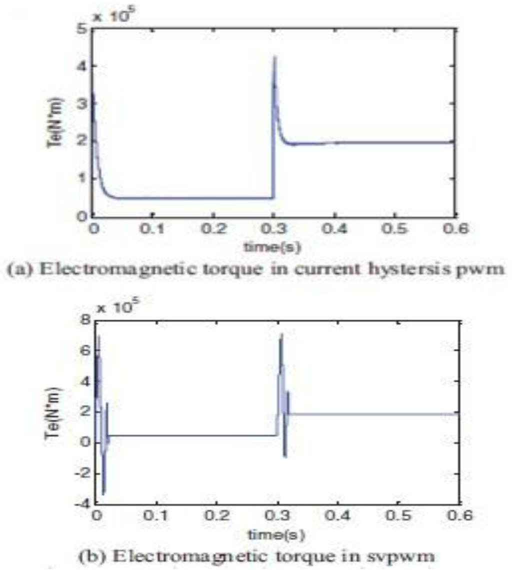


Fig. 5.Motorloadtorque in currenthystersispwmandsvpwm

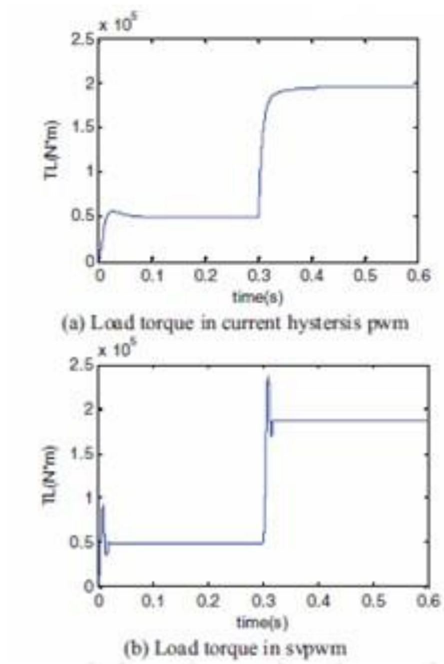


Fig. 6.Motorstatorcurrentincurrenthystersispwm andsvpwm

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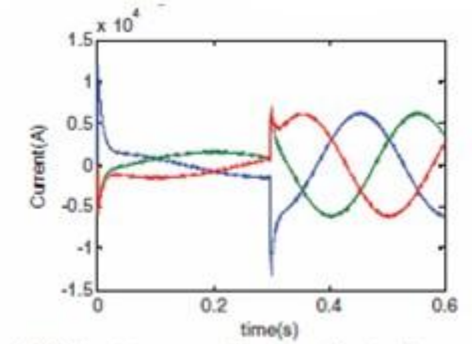
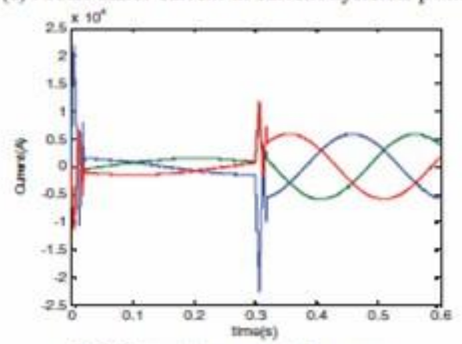


(a) Motor stator current in current hysteresis pwm



(b) Motor stator current in svpwm

Simulation time was set to 0.6 seconds Initially, the motor's speed was set at 100rpm, and it was increased to 200rpm at t=0.3s From the simulation production, it is apparent that the simulation phase is complex. on the left and right of Fig4 and the load on the right. Electromagnetic torque begins at approximately 4N*m, so the commanded speed was reached. Meanwhile, the load torque rose as the motor speed approached the command value, while the electromagnetic torque held steady. as the speed approached its rated speed, the torque was 2Nm. the stator peak current is at 6000A It meant that torque ripple is lessened.

VIII. CONCLUSION

Sim time was started with a default delay of 0.6 seconds. The engine speed started at 100 rpm, and was bumped up to 200 rpm at t=0.3s as seen by the simulated output waveforms that the device has strong dynamic efficiency Fig.4 and Fig.5 demonstrate the two forces acting on the engine –namely, respectively, the motor's and the propeller's. All in all other settings, the controller commands led to nearly four times the rate of magnetic torque (N-m/second), which caused the motor to rapidly accelerate to the command speed value. As the motor's speed grew, the electromagnetic torque increased to match it. At the rated speed of 200Nm/s the torque was obtained. Fig6. produces 6000A appears as the stator present peak value. Torsional vibration with the SVPW system is minimized.

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