Sensitivity Analysis of Dc Machine

Masood Rizvi
Associate Professor, Deptt. of Electrical & Electronics Engineering, KIET Ghaziabad.
Address 13 KM Stone, Delhi Meerut Road, Ghaziabad (U.P), India.

Abstract—In this paper, sensitivity analysis of DC machine parameters is done. Speed response of dc machine is determined in MATLAB/SIMULINK and the results are verified experimentally. The simulation studies helps in predicting the parameters and performance of DC machine.

Keywords—Sensitivity; parameter; back emf; inertia.

I. INTRODUCTION

With the advancement in the field of power electronics and VLSI, AC motors are used in industries wherever they are suitable or can give appropriate characteristics. However there remain certain important fields of application where the DC machines offer great economic and technical advantage. The foremost thing about DC machines is its versatility. Large DC motors finds application in machine tools, printing presses, conveyors, fans, pumps, hoists, cranes, paper mills, textile mills etc. Fractional horsepower DC machines are used as control devices for speed sensing in tacho-generators and as servomotors for positioning and tracking. DC motors have high efficiency. As the torque-speed characteristics of DC motor can be varied over a wide range while holding high efficiency they still dominate and they are used as traction motors in hoists, transit cars and locomotives. DC series motors have very high torque producing capabilities at start and are easy to miniaturize, and can be "throttled" via adjusting their supply voltage. DC motor is seldom installed in a situation where it is required to run at constant speed under constant load, since an induction motor performs such responsibilities satisfactorily, costs only a fraction of the price of a DC machine of equal power and speed and requires minimal maintenance. Many simple variable-speed systems are inherently stable in operation, so that the steady-state behaviour of a DC motor is frequently all that an engineer needs to take into consideration. For simple systems, a DC shunt motor excited from a single source is often satisfactory and provides a reasonable range of adjustable speed and torque.

II. DETERMINATION OF PARAMETERS

Mathematical Model of DC Machine and Simulation

Fig.1. Armature circuit of DC motor.

\[
\begin{bmatrix}
\frac{di_f}{dt} \\
\frac{di_d}{dt} \\
\frac{d\theta_f}{dt} \\
\frac{d\theta_d}{dt}
\end{bmatrix} =
\begin{bmatrix}
-\frac{1}{\tau_f} & 0 & 0 & 0 \\
0 & -\frac{1}{\tau_d} & 0 & 0 \\
-\frac{L_d}{J} & \frac{L_d}{L_a} & 0 & 0 \\
0 & 0 & -\frac{1}{J} & 0
\end{bmatrix}
\begin{bmatrix}
i_f \\
i_d \\
\theta_f \\
\theta_d
\end{bmatrix} +
\begin{bmatrix}
0 \\
0 \\
\frac{1}{L_a} \\
0
\end{bmatrix}
\begin{bmatrix}
V_f \\
V_d \\
0 \\
0
\end{bmatrix}
\]

(i) Measurement of Armature resistance & field resistance Ra & Rf
The resistance of the armature and field circuit are measured by using Wheatstone bridge
Ra = 3.3 ohm
Rf = 460 ohm

(ii) Measurement of Self inductance
The inductance is measured by universal bridge method.
L_a = 0.048H
L_f = 0.54 H

(iii) Coefficient of Viscous friction = 0.0162 Nm-sec.

(iv) Measurement of moment of inertia. H=0.0045

(v) Measurement of constant K_f=2.62
Table I : Swinburne's Test conducted at full excitation and reduced excitation for determination of Moment of inertia H

<table>
<thead>
<tr>
<th>S. No</th>
<th>Va</th>
<th>( I_a )</th>
<th>( V_a )</th>
<th>( I_a )</th>
<th>( V_a )</th>
<th>( P = \text{Wattmeter} \times I_a^2 R_a )</th>
<th>( N )</th>
<th>( % )</th>
<th>( % )</th>
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<td>85.14</td>
<td>85</td>
<td>85</td>
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<td>895</td>
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**TABLE II : MEASUREMENT OF MOMENT OF INERTIA**

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<tr>
<th>S.No</th>
<th>N</th>
<th>( T )</th>
<th>( dN )</th>
<th>( dT )</th>
<th>( dN/dT )</th>
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<td>780</td>
<td>2</td>
<td>845/60</td>
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<td>1015/60</td>
<td>6</td>
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<td>6</td>
<td>1160/60</td>
<td>8</td>
<td>145/60</td>
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<tr>
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<td>10</td>
<td>131/60</td>
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<tr>
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<td>10</td>
<td>1450/60</td>
<td>12</td>
<td>120/60</td>
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<tr>
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<td>0</td>
<td>12</td>
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**TABLE III : MEASUREMENT OF \( K_f \)**

<table>
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<tr>
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<th>( E_b )</th>
<th>( N )</th>
<th>( \omega )</th>
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Fig 2. Block diagram circuit of DC motor.

Fig 3. Simulink model of DC motor.

Fig 3. Speed response of DC motor
III. CONCLUSION

With aging the performance of dc motor decreases, therefore, it is desired by the engineers to evaluate the performance of dc motor from time to time for efficient operation. Conventional method for calculating output performances are time consuming so MATLAB based approach is used to evaluate the performance of DC motor. The results are verified experimentally.

REFERENCES