ENGINEERING BULLETIN E-1

HOW TO PLOT CURVES: SPEED/TORQUE – CURRENT/TORQUE

The data listed on each of Motor Technology's products is sufficient to be able to plot the speed/torque and current/torque curves for armatures available in each motor size.

While ratings are provided for each motor, they are rarely operated at that point.

A speed/torque curve must be plotted to identify the speed at which the motor will run. Plotting the current/torque curve on the same graph will identify the amperes required at that particular load point.

For a DC permanent magnet motor, the two "curves" are simple straight lines so only two points of data are required for each curve (or straight line) for plotting. *These data points are listed with each model in the online catalog.* To plot the speed/torque curve, two points are required: the ***No-Load Speed*** (point A) and the ***Stall Torque*** (point B). To plot the current/torque curve, two points are required: the ***No-Load Current*** (point C) and the ***Stall Current*** (point D).

***Case Study 1:* Model DMR-10 motor #150A100**

1. Using the data for the 150A100 motor, at 27 VDC input: Observe that the no-load speed for the DMR-10 is 10,550 rpm (point A on the curve in Figure 1, page 2). The stall torque value shown in the chart is 21.1 oz. in. (point B). Plot these two points on a graph and connect them with a straight line. This line shows the speed versus torque characteristics of the DMR-10 motor at 27 VDC input.
2. Continuing with the data, plot point C – the No-Load Current of .234 amps, and the Stall Current of 6.3 amps (point D). This last point is located directly above the stall torque (point B). Connect points C and D, and the current versus torque characteristics of this motor are revealed. Once the curves are plotted, applying various loads will always reveal at which speed and current the motor will run.

Case Study 2: ***Practical Example Model DMR-10 motor #150A100***

1. Consider this motor at a load of 2.0 oz. in. From the completed plot, it shows that the motor will run at approximately 9500 rpm and will draw 0.75 amps from the supply.
2. Expanding upon this example, consider the application has an intermittent loading of 7.5 oz. in. From the plot it is shown that the motor will slow down to approximately 6800 rpm and demand at 2.3 amps from the supply.

SPEED/TORQUE AND CURRENT/TORQUE CURVES

150A100-10 (DMR) @ 27 VDC

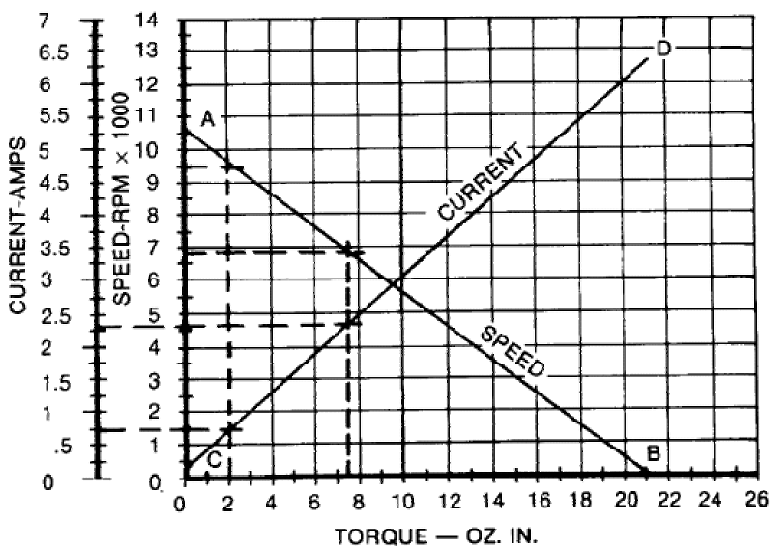

Figure 1

<u>Case Study 3:</u> Practical Example Model DMR-10 motor #150A100 with Change of Power Supply

1. The power supply generally does not provide a stable 27 VDC, or perhaps the supply is not a 27 VDC source but a 24 VDC source. The effect of such a change is easily calculated.
2. Permanent magnet motors have certain consistent characteristics:
    a. The no-load speed is directly proportional to the voltage.
    b. The slope of the speed/torque curve remains constant.
    c. The current/torque curve does not change when you vary the voltage.
        i. The no-load speed is directly proportional to voltage; hence, the no-load speed at 24 VDC would be calculated by dividing the no-load speed (10,550 rpm) by 27 VDC (rated input voltage) and multiplying that number by 24 VDC - the new voltage.
        ii. In this case, the no-load speed at 24 VDC would be 9377 rpm.
3. Plot this new point (see <u>Figure 2</u> , page 4) and draw a line through it parallel to the 27 VDC curve. This is the performance of the motor at 24 VDC.
    a. The current/torque curve does not vary with voltage, hence the current will remain the same.
    b. Expanding upon this example, consider this as a military application and that the power supply may produce as much as 30 VDC.
        i. The new no-load speed can be calculated by dividing 10,500 rpm by 27 VDC and multiplying that number by 30 VDC. The new no-load speed is then 11,722 rpm.
        ii. Plot this point and draw a line through it parallel to the 27 VDC curve. Each of these curves reveals which motor will perform at a particular voltage.
        iii. Refer to <u>Figure 2</u>: the motor speeds show that the load was 3 oz. in. and the voltage varied between 24 and 30 VDC:7800 rpm to 10,200 rpm.
            1. The current is a steady, 1.0 amp nominal.
            2. Note that the stall torque value of the motor did change from point D' to a high at point D" (approx. 18.5 to 23.3 oz. in.) as the stall current and stall torque are proportional to the applied voltage. Apply twice the voltage and get twice the stall current; likewise, half the voltage is half the stall current. Explanation: When the motor is stalled, the armature appears in the circuit as a resistor.

SPEED/TORQUE AND CURRENT/TORQUE CURVES

150A100-10 (DMR) @ 24, 27 & 30 VDC

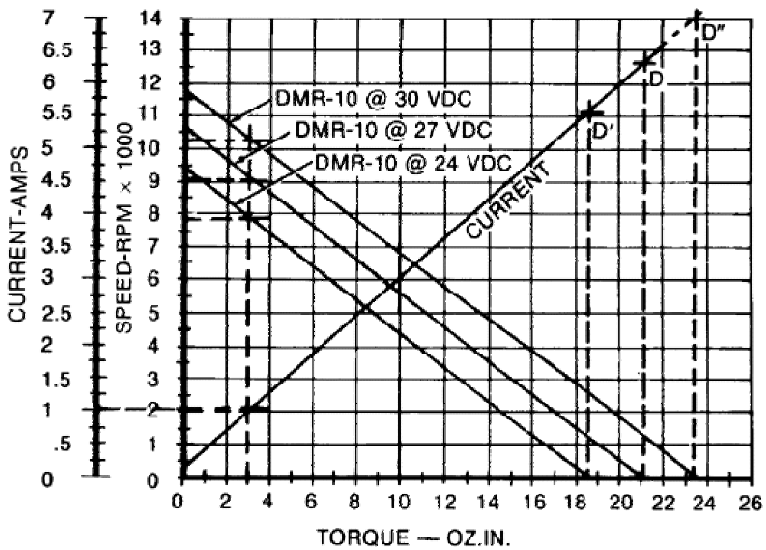

Figure 2