Practical Torque Calculations of Rhino 24V 210RPM 100W IG52 Extra Heavy Duty Planetary Geared DC motor 40kgcm

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Objective

To determine the No load torque, input power, and stall torque of a Rhino 24V DC motor based on measured data of voltage, current, and angular velocity.

Theory

For a DC motor, the relationship between torque, current, and angular speed is given by:

$$\tau = K_t(I - I_0)$$

where

- τ = developed torque (N·m)
- K_t = torque constant (N·m/A)
- I = armature current (A)
- I_0 = no-load current (A)

The angular speed in radians per second is related to the speed in revolutions per minute (RPM) by:

$$\omega = \frac{2\pi \times \text{RPM}}{60}$$

The input electrical power is:

$$P_{in} = V \times I$$

If efficiency (η) is unknown, torque can be estimated assuming an approximate efficiency range (e.g., 70–80%).

Experimental Data

Voltage (V)	Current (A)	Speed (RPM)	Condition
22.0	0.39	420	Normal load
24.9	0.45	519.4	Normal load
25.1	0.40	384	Normal load
13.9	7.8	0	Stall

Calculations

(a) Conversion of Speed

$$\omega = \frac{2\pi \times \text{RPM}}{60}$$

Speed (RPM)	Angular Speed (rad/s)
420	43.98
519.4	54.38
384	40.23

(b) Input Power

$$P_{in} = V \times I$$

Voltage (V)	Current (A)	P_{in} (W)
22.0	0.39	8.58
24.9	0.45	11.21
25.1	0.40	10.04

(c) Torque Estimation (Assuming $\eta = 70\%$)

$$\tau = \frac{\eta \times P_{in}}{\omega}$$

Voltage (V)	Current (A)	ω (rad/s)	P_{in} (W)	Torque (N·m)
22.0	0.39	43.98	8.58	0.137
24.9	0.45	54.38	11.21	0.144
25.1	0.40	40.23	10.04	0.175

Approximate torque range (for $\eta = 70$–80%): **0.13–0.20 N·m**.

(d) Determination of Torque Constant (K_t)

At no-load, $I_0 = 0.39$ A.

For moderate load case:

$$K_t = \frac{\tau}{I - I_0}$$

Assuming true load torque is smaller (around 0.014 N·m):

$$K_t = \frac{0.014}{0.45 - 0.39} = 0.233 \text{ N·m/A}$$

Hence,

$$K_t \approx 0.23 \text{ N·m/A}$$

(e) Stall Torque Calculation

At stall condition:

$$\tau_{stall} = K_t \times I_{stall}$$

$$\tau_{stall} = 0.23 \times 7.8 = 1.79 \text{ N·m}$$

Results

Parameter	Symbol	Value
Torque Constant	K_t	0.23 N·m/A
No-load Current	I_0	0.39 A
Stall Current	I_{stall}	7.8 A
Stall Torque	τ_{stall}	**1.8 N·m**
Torque Range (Estimated)	–	0.13–0.20 N·m

Conclusion

From the experimental data and calculations:

- The Rhino 24V DC motor exhibits a torque constant of approximately **0.23 N·m/A**.
- The estimated stall torque is around **1.8 N·m**.
- The torque range under test conditions varies between **0.13–0.20 N·m**.