Power and Efficiency Calculations

Electrical power, P_{elec}

$$P_{elec} = iV_{app-lift} = 4.40A(6V) = 26.39W$$

These values were measured during the lift test. ***i*** was calculated using the average of the readable currents during lifting.

Table 2

V_{app}	$\dot{\theta}_{m\text{-}20:1}$ (rad/s)	T_{load} (Nm)
3	47.125	0.00909
3.5	66.775	0.0106
4	74.613	0.0122
4.5	78.538	0.0139
5	90.325	0.0155
5.5	94.250	0.0172
6	96.825	0.0190

System efficiency, η_{sys}:

$$\eta_{sys} = \frac{P_{out}}{P_{in}} = \frac{P_{GB}}{P_{elec}} = \frac{5.595W}{26.39W} \approx 0.21$$

Where $\mathbf{P_{GB} = Fd/t_{lift}}$ and $\mathbf{P_{elec}}$ is calculated above.

Motor efficiency, η_{motor}:

$$P_{mech} = (\frac{k}{R} \cdot V_{app} - T_{fric})\dot{\theta_m} - \frac{k^2}{R}\dot{\theta_m^2}$$

$$= 4.89W$$

$$\eta_{motor} = \frac{P_{mech}}{P_{elec}} = \frac{4.89W}{26.39W} \approx 0.19$$

Where $\mathbf{P_{mech}}$ is calculated at 6V and the velocity is calculated from data gathered during the speed test (table 2) and converted with 20:1 GR.

Transmission efficiency, η_{trans}:

$$\eta_{trans} = \frac{T_{out} \cdot \dot{\theta_{out}}}{T_{motor} \cdot \dot{\theta_{motor}}} = \frac{F \cdot r_c \cdot \dot{\theta_{out}}}{k \cdot i \cdot \dot{\theta_{motor}}} = \frac{8.896N \cdot 0.011m \cdot 96.825\frac{rad}{s}}{0.002797\frac{Nm}{A} \cdot 4.4A \cdot 96.825\frac{rad}{s} \cdot 20} \approx 0.398$$