The values given in the ratings table on page 19 are based on uniform, smooth servo-operation. Since, in practice, applications are very diverse, it is essential to consider the given conditions by using the appropriate factors (see below). A maximum unit temperature of 176° F should not be exceeded. Formulas for determining power and torque with a rack & pinion drive on output:

$a = \frac{v}{t_b}$ [in/s²]

$m = \frac{W}{g}$ [lb.s²/in]

$F_T = m \cdot g + m \cdot a$ (for lifting axis) [lb]

$F_T = m \cdot g \cdot \mu + m \cdot a$ (for driving axis) [lb]

$T_{2req} = \frac{F_T \cdot (d/25.4)}{24}$ [lb.ft]

$n_2 = \frac{60 \cdot v}{(d/25.4)\,\pi}$ [rpm]

$i_{gear} = \frac{n_1}{n_2}$

$T_{2perm} = \frac{T_{2table}}{K_A \cdot S \cdot b_B}$ [lb.ft.]

The unit should be selected that $T_{2perm.} > T_{2req}$

$P_{1req.} = \frac{T_{2req} \cdot n_2}{5250 \cdot \eta}$ [hp]

Symbols

a	=	acceleration or deceleration rate	[in/s²]
b_B	=	operating time factor	
d	=	pitch diameter of pinion	[mm]
F_T	=	tangential acceleration force	[lb.]
g	=	acceleration due to gravity	[386 in/s²]
i	=	gearbox ratio	
K_A	=	load factor	
m	=	mass being moved	[lb.s²/in]
n_1	=	input speed of gearbox	[rpm]
n_2	=	output speed of gearbox	[rpm]
P_1	=	input power	[hp]
S	=	safety factor	
t_b	=	acceleration time	[s]
T_{2perm}	=	corrected acceleration torque	[lb.ft.]
T_{2req}	=	acceleration torque	[lb.ft.]
T_{2table}	=	rated output torque of reducer	[lb.ft.]
v	=	maximum linear speed	[in/s]
W	=	weight being moved	[lb]
η	=	gearbox efficiency at input speed	
μ	=	coefficient of friction of axis	
π	=	3.1415	

Load Factor K_A

Drive	Type of load from the machines to be driven		
	uniform	medium shocks	heavy shocks
uniform	1.00	1.25	1.75
light shocks	1.25	1.50	2.00
medium shocks	1.50	1.75	2.25

Operating Time Factor b_B

Operating time	4–8 h	8–12 h	>12 h
Operating time factor	1.00	1.20	1.35

Safety Coefficient S

The safety factor should be selected based on experience, typically S = 1.1 to 1.4.

Calculating Example

Values Given

○ Driving Axis ⊗ Lifting Axis

Weight to be moved: $W = 660$ lb

Linear speed: $v = 42.5$ in/s

Acceleration time: $t_b = 0.27$ s

Acceleration due to gravity: $g = 386$ in/s²

Coefficient of friction: $\mu =$

Pinion pitch diameter: $d = 63.66$ mm

Load factor: $K_A = 1.25$

Operation time factor: $b_B = 1.2$

Safety factor: $S = 1.2$

Input speed from motor: $n_1 = 3000$ rpm

Motor type:

Motor manufacturer:

Calculations

$a = \frac{v}{t_b} = \frac{42.5}{0.27} = 157.4$ in/s²

$m = \frac{W}{g} = \frac{660}{386} = 1.71$ lb.s²/in

$F_T = m \cdot g + m \cdot a = 1.71 \cdot 386 + 1.71 \cdot 157.4 = 929.4$ lb

$F_T = m \cdot g \cdot \mu + m \cdot a$ (for driving axis only)

$T_{2req} = \frac{F_T \cdot (d/25.4)}{24} = \frac{929.4 \cdot (63.66/25.4)}{24} = 97.0$ lb.ft.

$n_2 = \frac{60 \cdot v}{(d/25.4)\,\pi} = \frac{60 \cdot 42.5}{(63.66/25.4) \cdot \pi} = 323.9$ rpm

$i_{gear} = \frac{n_1}{n_2} = \frac{3{,}000}{323.9} \cong 9{,}25$

Assuming 58_5_09 reducer with $T_{2table} = 206.5$ lb.ft.

$T_{2perm} = \frac{T_{2table}}{K_A \cdot S \cdot b_B} = \frac{206.5}{1.25 \cdot 1.2 \cdot 1.2} = 114.7$ lb.ft.

The unit should be selected such that $T_{2perm.} > T_{2req}$

$T_{2perm} > T_{2req} = 114.7$ lb.ft. > 97.0 lb.ft.

$P_{1req} = \frac{T_{2req} \cdot n_2}{5250 \cdot \eta} = \frac{97.0 \cdot 323.9}{5250 \cdot 0.65} = 9.21$ hp

Your Calculations

Values Given

○ Driving Axis ○ Lifting Axis

Weight to be moved: $W =$ _____ [lb]

Linear speed: $v =$ _____ [in/s]

Acceleration time: $t_b =$ _____ [s]

Acceleration due to gravity: $g =$ 386 [in/s²]

Coefficient of friction: $\mu =$ _____

Pinion pitch diameter: $d =$ _____ [mm]

Load factor: $K_A =$ _____

Operation time factor: $b_B =$ _____

Safety factor: $S =$ _____

Input speed from motor: $n_1 =$ _____ [rpm]

Motor type: _____

Motor manufacturer: _____

Calculations

$a = \frac{v}{t_b} =$ _____ [in/s²]

$m = \frac{W}{g} =$ _____ [lb.s²/in]

$F_T = m \cdot g + m \cdot a =$ _____ [lb]

$F_T = m \cdot g \cdot \mu + m \cdot a =$ _____ [lb]

$T_{2req} = \frac{F_T \cdot (d/25.4)}{24} =$ _____ [lb.ft.]

$n_2 = \frac{60 \cdot v}{(d/25.4)\,\pi} =$ _____ [rpm]

$i_{gear} = \frac{n_1}{n_2} =$ _____ ≅ _____

Permissible torque T_{2table}, see page 19

$T_{2perm} = \frac{T_{2table}}{K_A \cdot S \cdot b_B} =$ _____ = [lb.ft.]

$T_{2perm} > T_{2req} =$ [lb.ft.]

$P_{1req} = \frac{T_{2req} \cdot n_2}{5250 \cdot \eta} =$ _____ = [hp]

Selection: 58_5_09 Servo-Worm Reducer, page 12, 20 29 ___ pinion shaft, page 25