Schlumberger

Rod Lift Application Formulas

Calculate values using set formulas

DEFINITIONS

- spm = strokes per minute
- rpm = prime mover revolutions per minute
- R = gear reducer ratio
- D = gear reducer sheave pitch diameter (in)
- d = prime mover sheave pitch diameter (in)
- v = belt velocity (ft/min)
- π = (pi) 3.1416
- PI = belt pitch length (in)
- CD = shaft center distance (in)
- U = see general dimensions
- V = see general dimensions
- AB = see general dimensions
- UU = see general dimensions
- VV = see general dimensions
- AA = see general dimensions
- b = prime mover backing (vertical distance from mounting feet to center of shaft) (in)
- hp = horsepower
- bbl/d = barrels per day at 100% pump efficiency
- Depth = pump setting (ft)
- L = stroke length (in)

Strokes per minute

Formula

$$spm = \frac{rpm}{R} \times \frac{d}{D}$$

Example

$$SPM = \frac{1{,}170}{30.12} \times \frac{12}{47} = 9.9$$

where spm = 1,170 rpm of prime mover
R = 30.12 ratio (320D gear reducer)
d = 12-in pitch diameter of prime mover sheave
D = 47-in pitch diameter of gear reducer sheave

Prime mover sheave diameter

Formula

$$d = \frac{spm \times R \times D}{rpm}$$

Example

$$d = \frac{12 \times 30.12 \times 47}{1{,}170} = 14.5 \text{ in}$$

where spm = 12
R = 30.12 ratio (320D gear reducer)
D = 47-in pitch diameter of gear reducer sheave
rpm = 1,170 rpm of prime mover

Use the nearest size available depending upon belt section and number of grooves in sheave.

Belt velocity

Formula

$$v = \frac{\pi \times d \times rpm}{12}$$

Example

$$v = \frac{3.1416 \times 14.5 \times 1{,}170}{12} = 4{,}441 \text{ ft/min}$$

Where: d = 14.5-in pitch diameter
rpm = 1,170 rpm of prime mover

Limit between 2,000 and 5,000 feet per minute (ft/min).
Belt velocity less than 2,000 ft/min results in poor belt life. Belt velocity greater than 5,000 ft/min requires dynamically balanced sheaves.

Belt length

Formula

$$PL = 2CD + 1.57(D + d) = \frac{(D-d)^2}{4 \times CD}$$

Example

$$PL = 2 \times 66.21 + 1.57(47 + 14.5) = \frac{(47-14.5)^2}{4 \times 66.21} = 232.96 \text{ in}$$

Where: CD = 66.21-in center distance of shafts
D = 47-in pitch diameter of gear reducer sheave
d = 14.5-in pitch diameter of prime mover sheave

Use the nearest belt size available depending on type of sheave

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Center distance

Formulas

$$CD = \sqrt{\left(U + \frac{V}{2}\right)^2 + (AB - b)^2} \qquad CD = \sqrt{\left(UU + \frac{VV}{2}\right)^2 + (AA - b)^2}$$

Example: Hi-prime electric motor driven C-320D-256-100 conventional unit

$$CD = \sqrt{\left(31 + \frac{33.25}{2}\right)^2 + (54 - 8)^2} = 66.21 \text{ inches}$$

where UU = 31 (see general dimensions)
VV = 33.25 (see general dimensions)
AA = 54 (see general dimensions)
b = 8 (assume 25 hp, Frame 324T, motor)

Horsepower of prime mover (approximate)

Formula A

$$HP = \frac{BPD \times Depth}{56{,}000}$$

Formula B

$$HP = \frac{BPD \times Depth}{45{,}000}$$

Example: High-slip (NEMA D) motor

$$HP = \frac{217 \times 5{,}600}{56{,}000} = 21.7$$ *(Use 25 HP motor)*

Where: bbl/d = 217 @ 100% pump efficiency
Depth = 5,600 ft, pump setting
Formula A: For high-slip (NEMA D) electric motors and slow-speed engines
Formula B: For normal slip electric motors and multicylinder engines

Multiply HP by 0.8 for Mark II units.

Maximum strokes per minute (based on the free fall speed of the rod)

Formulas

Conventional units Air-balanced units Mark II units

Example: For a C-320D-256-100 conventional unit.

$$spm = 0.7\sqrt{\frac{60{,}000}{L}} \qquad spm = 0.63\sqrt{\frac{60{,}000}{L}} \qquad spm = 0.56\sqrt{\frac{60{,}000}{L}}$$

$$SPM = 0.7\sqrt{\frac{60{,}000}{100}} = 17.15 \text{ spm maximum}$$

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