# 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)
- $\pi = (pi) 3.1416$
- 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

Example

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

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

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

Example

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

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

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

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

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

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

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

Fyamnle

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

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Use the nearest belt size available depending on type of sheave

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#### Center distance

**Formulas** 

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

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

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

Formula B

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

$$HP = \frac{BPD \times Depth}{45.000}$$

Example: High-slip (NEMA D) motor

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

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 spm maximum

rodlift.slb.com

