Pioneering for you

Raw Water Intake
Consulting guide

Motor Cooling of Submersible Pumps (Well Pumps)

Calculation of the flow velocity at the motor

A minimum flow velocity at the motor is necessary for submersible pumps to make sure the motor is properly cooled. If the flow velocity is too low, the motor can overheat and fail. Use the following formula to calculate the flow velocity at the motor's duty point:

$$V_F\,[m/s] = \frac{Q\,[m^3/h]}{\pi \div 4 \times 3600 \times (D_{well}^2\,[m^2] - D_{motor}^2\,[m^2])}$$

- Q = flow rate at the duty point in m^3/h
- D_{motor} = motor diameter in square metres
- D_{well} = well diameter in square metres
- V_F = flow velocity at the motor in m/s

Calculation

Calculation example for a Sub TWI 6.30-19-C:

Operating parameters
Flow rate (Q): 34 m^3/h
Delivery head (H): 121 m
Motor diameter 136,7 mm
Well diameter: 0.3 m
Min. flow velocity: 0.1 m/s
Max. fluid temperature: 30 °C

$$V_F\,[m/s] = \frac{34\ m^3/h}{\pi \div 4 \times 3600 \times (0.09\ m^2 - 0.0187\ m^2)}$$

Result

The flow velocity at the duty point is 0.17 m/s, which is larger than the minimum necessary flow velocity of 0.1 m/s. No further measures are necessary.

Notice: If the calculated flow velocity is lower than the minimum flow velocity, install a cooling shroud. The cooling shroud reduces the well diameter. This increases the flow velocity at the motor.

Calculation of the maximum well diameter

If you cannot install a cooling pipe, calculate the maximum well diameter using the minimum flow velocity. Use the following formula to calculate the maximum well diameter:

$$D_{well}\ max\,[m] = \sqrt{\frac{Q\,[m^3/h]}{V_{Fmin}\,[m/s] \times \pi \div 4 \times 3600} + D_{motor}^2\,[m^2]}$$

- Q = flow rate at the duty point in m^3/h
- D_{motor} = motor diameter in square metres
- D_{well} max = maximum well diameter in metres
- V_{Fmin} = minimum flow velocity in m/s

Calculation

Calculation example for a Sub TWI 6.30-19-C:

Operating parameters
Flow rate (Q): 34 m^3/h
Delivery head (H): 121 m
Motor diameter 136,7 mm
Min. flow velocity: 0.1 m/s
Max. fluid temperature: 30 °C

$$D_{well}\ max\,[m] = \sqrt{\frac{34\ m^3/h}{0.1\ m/s \times \pi \div 4 \times 3600} + 0.0187\ m^2}$$

Result

The maximum well diameter is 373 mm. If the well diameter is larger, install a well pipe to keep the well diameter at 373 mm.

Notice: This calculation does not include other factors, such as motor partial load operation, pump overloading, or higher fluid temperatures.

Flow velocity with frequency converter operation

When running the pump with a frequency converter, make sure that the minimum flow velocity is reached at the lowest speed:

Notice: The specified control range varies for each series. Check the control range for each pump.

$$Q_{min} @ n_{min}\,[m^3/h] = \frac{n_{min}\,[rpm]}{n_{nominal}\,[rpm]} \times Q_{nominal}\,[m^3/h]$$

1. Calculate the flow rate at the lowest speed.
2. Use this value to calculate the flow velocity at that speed.
3. Make sure that the flow velocity at the lowest speed meets the minimum requirement.

Use the formula below to calculate the flow rate at the lowest speed:

- $Q_{nominal}$ = flow rate at the duty point in m³/h
- $n_{nominal}$ = speed at 50 Hz
- n_{min} = speed at 30 Hz
- Q_{min} = flow rate at minimum speed in m³/h

Calculation

Calculation example for a Sub TWI 6.30-19-C:

Operating parameters
Flow rate (Q): 34 m³/h
Delivery head (H): 121 m
Motor diameter 136,7 mm
Well diameter: 0.3 m
Min. flow velocity: 0.1 m/s
Max. fluid temperature: 30 °C
Nominal speed: 2900 rpm @50 Hz
Minimum speed: 1740 rpm @30 Hz

$$Q_{min} @ n_{min}\,[m^3/h] = \frac{1740\ rpm}{2900\ rpm} \times 34\ m^3/h$$

$$V_F\,[m/s] = \frac{20.4\ m^3/h}{\pi \div 4 \times 3600 \times (0.09\ m^2 - 0.0187\ m^2)}$$

Result

The flow velocity is 0.1 m/s at a minimum speed of 1740 rpm. The minimum necessary flow velocity is also 0.1 m/s. Thus, the pump is adequately cooled in the control range.

Notice: If the calculated flow velocity is less than the necessary minimum flow velocity, install a cooling pipe or increase the minimum speed.

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