

Condition Monitoring for Cooling Tower Fans

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Cooling Tower Fans have applications in all industries. They remove heat from other materials, usually water. A cooling tower may consist of one cell or many individual cells in a single structure. A single plant may have multiple structures. Cooling Tower Fans come in two basic types. The first type has the motor mounted to the side of the cell and uses a jackshaft to drive the gearbox in the center. The second type has both the motor and gearbox centrally mounted in the cell. The mechanical components of a Cooling Tower Fan are made up of, Motor, Jackshaft (Optional), Gearbox, and Fan Blades.

The motor speed for a Cooling Tower Fan is usually 1800 RPM. Fan speeds are much slower and determined by the diameter of the blades to keep the blade tips subsonic. Average cells are 14 feet to 28 feet in diameter. Fan speeds of 90 to 230 RPM are normal for cooling tower fans. In cooler climates, the fans can be reversing to prevent freeze during the winter.

The most common Cooling Tower Fan failure involves the gearbox or fan blades and is catastrophic in nature. In many cases, this type of failure leaves the gearbox and fan blades lying in the cooling water pond at the bottom of the tower.

Many Cooling Tower Fans are equipped by the OEM (Original Equipment Manufacture) with an earthquake detection type devices mounted close to the cell. Although questionable to start with for this application, over time most of these devices have quit working due to corrosion or neglect.

Permanent monitoring is the recommended solution for preventing cooling tower cell failures. Periodic measurement programs rarely produce the desired result. In most cases, the location and environment discourages any attempts to take data or visually inspect the fan.

Permanent monitoring of a cooling tower fan cell requires direct monitoring of the most important component by mounting a transducer directly on the gearbox. Additional system protection can be added by mounting transducer(s) to the motor. Additionally, knowledge of the expected vibration frequencies is important.

1. Fan Speed 90-300 RPM
2. Blade Pass (Fan Speed X # of Blades)
3. Gear Mesh Frequencies
4. Motor Speed
5. Bearing Frequencies

Gear Vibration

The central component of a cooling tower is the gearbox. This is often a high maintenance source due to aerodynamic loading from the fan, excessive loading on the gear teeth, and improper alignment of the gear to the motor.

The gearbox is always located within the cooling water stream requiring special consideration for mounting a vibration sensor. The environment is usually caustic due to chemicals added to control the pH level of the cooling water.

A vibration sensor must be able to measure the expected gear mesh frequency, blade passage, and bearing defect frequencies. Other frequencies of interest include fan balance and motor alignment.

Gear and bearing defect frequencies tend to be the highest frequencies, while the fan balance frequencies are the lowest to be monitored. The other frequencies are found scattered between these extremes.

Monitoring the gearbox can be accomplished by installing a single low frequency accelerometer (SKF CMSS793V) on the gearbox in a horizontal orientation perpendicular to the jackshaft. The output signal should be routed to CMCP500 Series Monitors. One monitor should be specified to measure velocity for higher frequencies like gear mesh. The second monitor should be specified to integrate the signal to displacement terms for lower frequencies such as blade speed and blade pass.

- (1) CMSS793V Accelerometer 100mV/In/Sec Output.
- (1) CMCP692-32-01-02-01 Armored Extension Cable.
- (1) CMCP200-01 Mounting Pad 1/4"
- (1) CMCP230 Mounting Stud
- (1) CMCP220 Acrylic Adhesive Bypac
- (1) CMCP530-100V-02P-00-00 Velocity Monitor
- (1) CMCP535-100V-30-00-00 Displacement Monitor

Motor Vibration

Motor vibration frequencies of interest include motor unbalance, rotor bar defects, output shaft alignment, and bearing defect frequencies. A complete continuous monitoring approach should include one accelerometer per bearing location. Mounting orientation for the accelerometers should be horizontal at the bearing. As the motor speed is usually 1800 RPM economical standard accelerometers such as the SKF=s CMSS786 can be used. A more economical approach would be to mount a single accelerometer at the motor output shaft bearing location only.

- (2) CMSS786 Industrial Accelerometer
- (2) CMCP692-16-01-02-01 Armored Extension Cable
- (2) CMCP200-01 Mounting Pad 1/4"
- (2) CMCP230 Mounting Stud
- (2) CMCP220 Acrylic Adhesive Bypacs
- (2) CMCP530-100A-02P-00-00 Velocity Monitor

Start Up Considerations

All CMCP500 Series Monitors are provided with relays, reset terminals and a trip multiply function. Cooling Tower Fans experience large amounts of vibration during start-up. Either timer logic or a contact to energize trip multiply needs to be provided if the monitors are wired to shutdown.

DCS/PLC Systems

The CMCP500 series monitors can be equipped with Modbus or TCP/IP communications. I/O can be specified to provide operators with vibration levels; alarm set points, discrete alarms and the ability to energize the trip multiply and reset functions. A complete system using Modbus or TCP/IP can be specified providing operators with screens and software.