

FRANKLIN AID



Franklin Electric

The Company You Trust Deep Down



Franklin Application/Installation Data (AID)... For The Professional Pump Installer and Driller

Issue 1 AU-NZ August 2008

WHY SUBMERSIBLE MOTORS FAIL - Part 1

As we look at our submersible motors and their usage, we keep one goal in mind. That goal is quality. Quality products and installations equal long service life and long service life generally equals satisfied customers. Over the years, Franklin has reviewed many motors returned from the field. Along with looking at the returned motor itself, Franklin examines numerous applications and systems, looking for problems which contribute to premature motor failure. In the next few issues of Franklin AID we will with you some of the ways you can avoid application related problems and get the longest life out of your pump installation.

Although several items in this article apply to single-phase motors and systems, the majority is on the three-phase installations. Basically there are three types of motor failures; electrical, mechanical, and mechanical failures that progress into electrical failures. In this issue, we will focus on the electrical side.

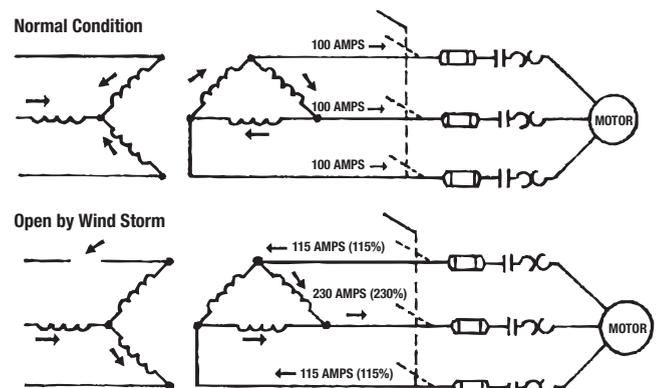
Eighty percent (80%) of motor electrical failures are a result of stator winding burnout. Most winding failures occur due to primary or secondary single-phasing, extreme high or low voltage, phase unbalance on three-phase motors, high voltage surges, or direct strikes of lightning. The good news is that in most cases these conditions are preventable.

The best way to prevent the above winding failures in three-phase motors is by using properly sized time-delay fuses in conjunction with Class 10, ambient-compensated overload protection and a good quality surge arrester. Franklin adds overload protection inside the motor on all 4 inch 2 wire 50 Hz motors and in the Control Boxes on other 4 inch motors. We also build in lightning protection on all 4 inch single phase motors to maximise protection.

In order for a surge arrester to be effective, it must be grounded to the water strata. Water strata is the actual water underground. Any surge in the system is looking for the easiest path to true water ground. The faster this surge is directed to ground, the less damage it can cause to your system. Grounding the arrester to only a driven ground rod may not be an adequate ground as the resistance through the soil is higher in some areas than others. Higher resistance means the surge will look for an easier path to ground, which may be through your motor. Connecting the ground wire from the arrester directly to the motor is the best ground available. All grounding and electrical work must comply with AS/NZS3000 and all revisions.

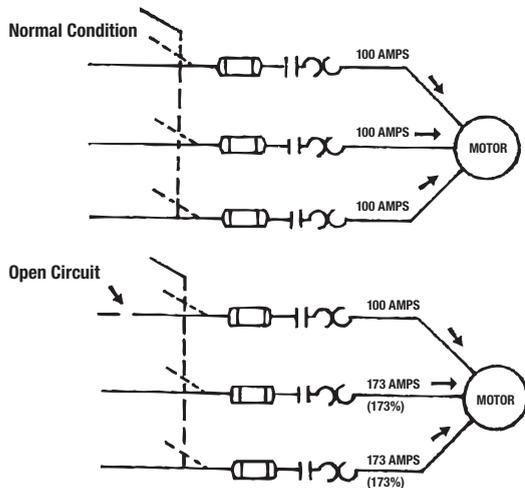
Single-Phasing: Single-phasing on a wye-delta three phase power distribution system can be disastrous to a three-phase motor, unless it has excellent overload protection. There are two types of single-phasing; primary and secondary. Primary single-phasing (see figure 1) occurs when one line on the high voltage or primary side of the transformer is opened. This can be caused by a tree limb falling across the lines or a car accidentally hitting a power pole. Single-phasing of the primary causes the motor amperage on two of the three lines to increase to 115%, while the third line increases to 230%.

SINGLE PHASING ON PRIMARY – FIGURE 1



Secondary single-phasing (see figure 2) occurs when one line on the motor side or secondary side of the transformer is opened. This can be caused by storm damage, loose connections or insulation problems in the wiring that blow fuses. Single-phasing of the secondary causes the motor amperage on the remaining two lines to increase by 173%, while the third line drops to zero.

SECONDARY SINGLE PHASING – FIGURE 2



Voltage Effects: High voltage and low voltage affect the operating amperage of the motor. Franklin designs the motor windings to tolerate a voltage range of plus 10% or minus 6% from nameplate voltage. In this voltage range, the amperage changes very little due to voltage fluctuations. However, once the voltage is outside of this range, the motor cannot do its job without excessive heating of the windings. High voltage causes the motor windings to saturate, while low voltage starves the motor of power. **Note: Both high voltage and low voltage cause high amps in the motor.** High amps are defined by an amperage reading that exceeds the nameplate maximum amps rating (S.F. max or FL max amps). If you envision amperage of the motor to a car's tachometre, amperage higher than service factor maximum is like a tachometre reading into the "redline". Nobody knows how soon the car will quit, but everyone knows the engine is suffering damage.

Unbalance: Current unbalance on three-phase motors is caused by unequal voltage being presented to each winding. A 1% voltage unbalance will result in approximately 6-10% current unbalance. This unbalance causes extreme heat in the motor windings. When the motor is lightly loaded (amperage significantly below full load amps), a 10% current unbalance is not harmful to the motor. When a motor is loaded to or maximum amperage, a current unbalance greater than 5% will cause excessive heating. Excessive heat build-up in the motor windings greatly affects the life of the motor. For every 10°C the internal winding temperature is increased, the life of the motor is cut in half. For instance, if the motor is normally designed to have an internal temperature of 30°C with a life expectancy of 10 years, raising the winding temperature to 40°C cuts the life to 5 years. An increase in winding temperature to 50°C shortens the life to 2½ years. Current unbalance and the resulting winding temperature must be avoided for normal motor life expectancy.

In the next issue of Franklin Aid we will continue to discuss "Why Submersible Motors Fail".

TOLL FREE HELP FROM A FRIEND

Phone Franklin toll-free on **1300 FRANKLIN** for answers to your installation questions on submersible pumps and motors.

When you call, we will offer assistance in troubleshooting submersible systems and provide answers to your pump and motor application questions.

www.franklin-electric.com.au



Franklin Electric

Toll Free: 1300 FRANKLIN
franklin-electric.com.au

FRANKLIN AID



Franklin Electric

The Company You Trust Deep Down



Franklin Application/Installation Data (AID)... For The Professional Pump Installer and Driller

Issue 2 AU-NZ August 2008

WHY SUBMERSIBLE MOTORS FAIL - Part 2

Voltage Surges and Spikes: High voltage surges and voltage spikes are the result of close proximity lightning strikes, opening of powerline switch gear, fast current-limiting power line switch gear, or the removal of large inductive loads from the powerlines. These spikes and surges can travel to the motor windings, where they attempt to break down the insulation resistance. While Franklin motors can handle voltage surges in the magnitude of 10,000 volts, unfortunately, power surges do not limit themselves to this voltage. This is why a good surge arrester, capable of multiple hits, is needed for submersible motors without internal arrestors (4-inch single-phase motors have built-in arrestors). Remember, there is little advantage to installing an arrester unless it is grounded to the water strata. Surge arrestors over the years have also been known as lightning arrestors. While a direct lightning strike of millions of volts to the motor is almost impossible to protect against, voltage surge related motor failures can be prevented with good arrestors and proper grounding.



1-phase



3-phase

Joslyn Manufacturing's single phase arrester is available through Franklin Electric, while the 3 phase arrester is used in Franklin's SubMonitor Premium kits. These arrestors are also sold separately in the market.

Now that we have addressed electrical failures in submersible motors, let's focus on how mechanical problems affect motor life.

When reviewing mechanical failures, the typical problems are shaft spline damage, broken or twisted shafts, and radial bearing, thrust bearing, or up thrust bearing damage.

Shaft Damage: Spline wear can be attributed to sand deposits, lime deposits, mis-alignment between the pump and motor, upthrusting, a loose fitting coupling, or any combination of these. Before assembling the spline coupling to the motor shaft, the coupling should be filled with a non-toxic FDA approved water proof grease (Mobil FM 102, Texaco Cygnus 2661 or FDA approved equivalent). This inhibits the entrance of sand or lime deposits into the spline area.

Broken or Twisted Shafts: Broken or twisted shafts are typically the result of a motor starting while back-spinning, a "machine gunning" starter, a water logged pressure tank, or continuous shaft side load.

Back-spinning is caused by a failed check valve or a lack of check valves. If the motor is started while back-spinning, this sudden reversal severely strains the pump and motor assembly and can cause shaft damage.

"Machine gunning", or ultra-rapid starting and stopping of the motor, places excessive stress loads on the motor shaft, coupling, and pump shaft. This is caused by a problem in the control circuit. Loose electrical connections and partial shorts to ground are some of the conditions that will cause "machine gunning" of a starter.

A water logged pressure tank also causes rapid cycling that results in broken or twisted shafts. This condition shock loads the motor's thrust bearing and can contribute to thrust bearing failure, as well.

A fixed or continuous shaft side load can cause a broken or twisted shaft and/or radial bearing damage. Pump bolts working loose, mis-alignment between the pump and motor, or bent shafts can cause shaft side load. Excessive side loading overloads the top motor bearing journal. This can cause the shaft to overheat and twist off in the journal area.

Radial Bearing Damage: Radial bearing or shaft side-load bearing failures are typically the result of sand or abrasive entry into the motor after the shaft seal is worn out. However, continuous side loading of the shaft, as mentioned above in the broken shaft section, can also cause radial bearing failure prior to shaft breakage. Once the radial bearing fails, the resulting debris from the radial bearings can produce excessive wear on the thrust bearing and lead to eventual failure of the motor.

Thrust Bearing Damage: In addition to the water logged pressure tank mentioned earlier, water hammer, dead-heading the pump, insufficient water flow past the motor, and back-spinning damages thrust bearings.

The shock wave caused by water hammer, shatters the thrust bearing. The shock wave travels down the water column to the pump shaft and onto the motor's thrust bearing. This shock wave is similar to a train engine coupling to a line of freight cars. When the engine hits the first car, it hits the second and so forth, all the way to the caboose. The thrust bearing is the caboose of a submersible motor and pump.

Dead-heading (running the motor, but not moving any water) and insufficient water flowing past the motor causes extreme heating of the motor fill solution. These conditions are usually caused by running against a closed valve, frozen water line, or blocked outlet. Top-feeding wells, motors installed in open bodies of water, or motors buried in mud or sand, do not allow enough water to move past the motor, unless a flow sleeve is used. Once the fill solution heats up and turns to steam, all bearing lubrication is lost and the thrust system fails.

Back-spinning of the pump allows the water to flow back through the pump as the water column drops to static level. While the water is draining back, the pump spins the motor at a low RPM. The speed of the motor is typically not high enough to properly lubricate the thrust bearing and bearing failure results.

Upthrust Damage: Upthrusting occurs when the pump is moving more water than it is designed to pump. On a pump curve, this typically means the pump is running to the "right side" of the curve, with less head or back pressure on the system than intended. With most pumps, this causes an uplifting or upthrusting on the impeller/shaft assembly in the pump. While Franklin submersibles have upthrust bearings which allow limited upthrust without motor damage, it should be avoided to minimise wear in the pump and motor. Continuous upthrusting damages the motor's upthrust bearing, imparts debris into the motor, and eventually causes a thrust bearing failure.

The final system failure category is mechanical failures that progress into electrical failure. In the which came first, the chicken or the egg scenario, electrical failures will rarely cause mechanical failures. However, many mechanical failures progress into electrical failures once the radial bearings wear enough to allow the rotor to rub the stator liner. When the stator liner is breached, the motor is taken (DTE) Down To Earth or grounded.

During our motor review process and system analysis, we also track stator winding failures and their direct relation to control circuit problems. Control circuit difficulties cause winding failures through the increased internal temperatures caused by repeated high inrush current. This destroys starter and pressure switch contacts, which can lead to low voltage or single-phasing.

In the last two issues of the Franklin AID, we have reviewed how system problems contribute to motor failure. By understanding the cause and effect relationship, we hope our readers may recognize some of these system problems and be able to take the necessary steps to get the longest life from their motor. If you have any questions or need assistance, don't hesitate to contact us on **1300 FRANKLIN**.

TOLL FREE HELP FROM A FRIEND

Phone Franklin toll-free on **1300 FRANKLIN** for answers to your installation questions on submersible pumps and motors.

When you call, we will offer assistance in troubleshooting submersible systems and provide answers to your pump and motor application questions.

www.franklin-electric.com.au



Franklin Electric

Toll Free: 1300 FRANKLIN
franklin-electric.com.au