Baldor Motor Basics — Part 12
Handling 50 Hertz Requirements

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(*Note from the editors*: *This 12th installment of Baldor Motor Basics brings the series to a close. We hope you found the information presented to be useful and relevant to your needs, and perhaps settled some questions for which you sought answers. Our thanks to Baldor and author Ed Cowern for their generous cooperation and expertise.*)

Introduction

As American manufacturers increase exports to 50 hertz countries, there arises the problem of supplying motors for 50-hertz service at an array of unfamiliar voltages. Fortunately there are some possibilities available that make it feasible to handle many of these requirements without waiting for special designs.

The first choice should always be to utilize a stock 50-hertz motor. If the basic motor exists but needs some type of modifications, they can frequently be handled through the Mod Express (*baldor.com*) program to get exactly what is needed.

If a 50-Hz stock motor either doesn't exist or cannot be modified to match the requirement, then some other alternatives exist.

In order to provide a description of these alternatives, we must first break it into two major groups: three-phase and single-phase.

Three-phase motors. When three phase motors are required, the situation can be quite simple. One rule-of-thumb that comes in very handy is as follows:

When the ratio of volts-to-hertz stays constant, the motor can be operated at the reduced frequency and reduced voltage.

Under this condition the motor will provide the same operating torque that it would provide at its 60-hertz frequency. Please note that the stipulation — the same torque — should be remembered. An example may help illustrate the situation.

A standard induction motor rated at 1 HP, 3 phase, 230/460 volts, 60 hertz would be checked out as follows: $460 \div 60 = 7.66$ volts-per-hertz. In this case, the matching 50-hertz voltage would be $50 \times 7.66 = 383$ volts. Thus the standard 60-hertz motor could be used at 50 hertz on voltages of 190 or 380. Under this condition of reduced voltage and frequency, the motor could be expected to generate the same amount of torque as it would on the normal 60-hertz application. In this case, it would be 3 lb. ft. of torque.

The speed of the motor would of course be lower than it would be on 60 hertz. Normally, you would expect to get a speed that is roughly five-sixths of the 60-hertz speed. In the case of a 1,725 PM motor, you would normally be 1,425 RPM when the motor is operated on a 50-hertz power system.

What about horsepower? Since horsepower is the product of speed and torque, you would expect that the horsepower output would be five-sixths, or slightly over 80 percent, of the 60-hertz rating. In order to overcome this problem there are two approaches.

One would be to select the next-larger HP rating. Thus, in the example cited above, a 1½ HP motor could be used to handle very nicely the 1-HP requirement at 50 hertz. In most cases the incremental cost of selecting the next-higher horsepower is substantially less than the cost and time involved in ordering a special unit. This de-rating approach is a sound and conservative one that can be used on virtually all applications involving open drip-proof and totally enclosed motors and brake motors. A motor selected in this manner can be re-nameplated to the new voltage, HP, speed and frequency combination. Due to the inherent, conservative designs used in Baldor motors and the normal voltage tolerances, many stock motors can be operated on 200 volts, 3-phase, 50 hertz or 400 volts, 3-phase, 50 hertz. Some can also be operated on 415-volt, 50-hertz systems. These combinations of 200, 380, 400 and 415 are the most frequently occurring 50-hertz voltages.

A second approach allows you to handle many of the 50-hertz requirements without de-rating. This is a little more involved and might normally be considered where special motors exist or where there are specific frame size restrictions that do not allow for an increase to the next-larger HP rating.

The approach in this case involves asking a few specific questions and having a reasonable understanding of the type of load that is being driven.

The basic question is this: Is the machine going to be identical in all respects to its 60-hertz counterpart?

If the answer to that question is "yes," a second question should be asked: Are you going to allow your machine to run at five-sixths of the 60-hertz speed or are you going to change transmission components such as gearing, belts, pulleys, etc. to increase the output speed up to the normal rate that you would get if the motor were to be running on 60 hertz?"

In this case, if the customer is going to change components in the machine to maintain the performance of the machine up to the 60-hertz capability, then the approach of oversizing, as discussed previously, should be used.

If, on the other hand, the machine is identical and the customer is going to operate it at reduced capability, then the torque required to drive the machine would normally be the same torque or, in some cases, less than the 60-hertz torque requirement. If the torque requirement is the same or less, then the motor need not be de-rated since the machine's requirements have been decreased and the motor would still be a perfect match for the machine. There are also many Baldor motors that can be operated at the rated horsepower on 50-hertz requirements without exceeding their rated temperature rise. Thus, a third option also exists — but it involves a good deal more searching to determine if a motor can be utilized to handle specific requirements.

Other voltages. Aside from the three commonly occurring 50-hertz voltages that have been described previously, there also arises from time to time requirements for others — such as 440 volts, 50 hertz. When the rule of thumb is applied to standardly available motors, it turns out that this voltage is not one that can be handled by normal de-rating processes. In this instance a special motor would have to be wound or an existing motor could be rewound by a service shop to match this requirement. In some instances, 575-volt, 60-hertz motors can be utilized to handle voltages of 480, 50 hertz or as high as 500 volts, 50 hertz. When this occurs, the normal procedures for de-rating, as listed previously, can be applied.

Single-phase motors. Single-phase motors present a unique problem, involving two conditions:

1. The winding must match the 50-hertz frequency and voltage.
2. The centrifugal starting switch must be set to operate at the right point as the motor accelerates during its starting period.

The simultaneous requirement for both of these items usually makes it impossible to utilize normal 60-hertz motors for 50-hertz, single-phase requirements. In most instances it may be possible to rewind an existing 60-hertz motor and change the centrifugal starting switch to one that is appropriate for 50-hertz operation. This procedure is fairly costly and time consuming.

A second option exists with Baldor's selection of single-phase, 50-hertz motors in the range of horsepower from ⅓ to 5. These motors are specifically designed for 50-hertz operation on either 110 volts or 220 volts (5 HP, 220 volts only). They are rigid base motors in both open drip-proof and totally enclosed. When C flanges are required, footless C face 1,425- and 2,850-RPM motors are offered in a range of sizes from ⅓ to 2 HP. C flange kits are available to convert stock motors from the standard mounting to a C flange mounting. Since the bases are welded on, it is not feasible to remove the base in order to get a footless motor, but most customers will not object to having both the C flange and rigid base if they can get availability of the basic unit.

Explosion-proof motors. Explosion-proof motors present some unique problems; basically, they conform to the same rules that have been discussed previously. However, due to the UL (Underwriters Laboratory), many of these motors cannot be re-nameplated to alternate voltages or frequency. The reason for this hinges on the safety aspects of the explosion-proof designs, as well as the thermal overload coordination situation. Thus, explosion-proof, 50-hertz motors that are not typically stocked — both single- and three-phase — must be special ordered.

Many three-phase Baldor explosion-proof motors are already supplied with a 50/60-Hz nameplate.

Summary

By using the techniques described, it is possible to handle a very high percentage of the normally occurring 50-hertz voltage requirements. If you should have questions, please contact Baldor for assistance (*baldor.com*). **PTE**

Operating Motors in Wet or Damp Environments

When electric motors are installed in wet or damp areas, the life of the motor is almost always shortened from what would be expected in a dry situation. However, there are several cautions and suggestions that can extend the life of motors in these less-than-ideal situations.

Open drip-proof motors. Generally speaking, open drip-proof motors are not suitable for wet environments. However, there are many situations where an equipment manufacturer chooses the open drip-proof motor (probably because of its lower first cost) for use where a totally enclosed motor would have been a better and longer life choice. If an open drip-proof motor is in place, a few suggestions can help extend motor life.

First, the motor should be shielded from the direct impact of rain, fog, snow, etc. In shielding a motor from the elements, caution should be used not to restrict air flow to and around the motor. Thus, putting a shelter over the motor is a fine idea — as long as the shelter is well ventilated or louvered so that hot air is not trapped inside.

Next, it is important to realize that open drip-proof motors are built to be mounted with a certain orientation. For example, many open drip-proof motors have "venetian blind"-type louvers in the end housings to make water that is falling from above deflect away from the inside of the motor. This works fine — except when motors get mounted to a wall or with feet up (ceiling mounting). In the ceiling-mounted case, unless the position of the end housings is changed relative to the base of the motor, the louvers will have a funnel effect directing rain, snow and other debris into the windings to shorten the life of the motor. In these cases, end housings should be rotated to put the louvers in the proper position to fend off rain, rather than funneling it inside.

The use of open drip-proof motors outdoors or in wet areas is not ideal. In the event of a failure, the motor should be replaced with a motor more suitable for an outdoor or wet environment.

Totally enclosed, fan-cooled. Totally enclosed, fan-cooled motors are more adaptable to outdoor and high-moisture areas and, with a bit of caution, they will work well. The following suggestions will help extend the life of totally enclosed motors.

Totally enclosed, fan-cooled motors have "weep holes" at the bottom of the end housings. Weep holes, or fittings, are put there to allow condensation or other accumulations of moisture to drain. At times, motors are mounted in unusual positions, such as with the shaft horizontal but with the base mounted on a vertical wall. In this case the weep holes are out of position by 90 degrees and the only time they could do their job would be when the motor is half-full of water. This, of course, is unacceptable. When motors are going to be used in different positions, care should be taken to reposition the end brackets so the weep holes are at the lowest point of the motor. This is especially important in applications such as the brush drives used in car washes and similar situations where water is apt to be falling on the motors continuously. In this situation some water can always be expected to enter the motor. The key to extending motor life is to give it an easy way out. On motors that are mounted at odd angles where the weep holes cannot be properly re-positioned to the lowest point, the problem can be remedied by carefully drilling a small hole at the lowest point. Caution must be taken to be sure power to the motor is disconnected and the drill bit does not touch or damage the windings or motor bearings.

Motors such as the Baldor "Wash-Down Duty," "Dirty Duty" and "Severe Duty" are designed to seal the motor and prevent the entrance of moisture. However, try as we might, it is nearly impossible to keep all water out. It is therefore vitally important that the weep holes be positioned so that water entering the motor — either by direct impingement or by exchange of air saturated with dampness — can drain away freely rather than accumulating.

One other source of water in a motor is condensation that can occur as a result of repeated heating and cooling cycles. For example, when the motor gets hot, the air within the motor expands and pushes out. Later, when the motor cools, fresh moisture-laden air will be drawn in as the air contracts. As this cycle repeats again and again, substantial quantities of water can accumulate. If left unchecked, it will lead to insulation failure.

Again, this highlights the importance of having the weep holes properly positioned so that water can drain before it accumulates in sufficient quantities to damage the motor.

Where motors run continuously, the heat generated in the motor by normal operation can keep windings dry. But when a motor is used infrequently and is subject to large swings in temperature, there are two methods that can be used to reduce the susceptibility to failure caused by accumulated moisture.

The first and most popular method is the use of heaters installed within the motor. In this case, cartridge heaters or silicon rubber strip heaters are placed within the motor and are turned on during the non-operating periods. The object of this method is to maintain the temperature inside the motor approximately five-to-ten degrees warmer than the surrounding air. When this is done, condensation inside the motor is prevented and the motor will stay dry. The heater method is similar to the way light bulbs are used in closets where the climate is humid to prevent mildew on clothing and leather goods.

When internal heaters are used, they are interconnected with the motor starter to turn on when the motor is not running, and off when the motor is running.

The second method of accomplishing the same result is a system called "trickle heating." In this case a source of low-voltage, single-phase power is applied to the three-phase motor windings when the motor is at rest. This results in a low-energy, single-phasing condition that produces heat in the windings, rotor, and, indirectly, the shaft and bearings of the motor. This system is a good one for preventing condensation in motors that are at rest. Trickle heating is particularly good where there are groups of identical motors, such as those used on aerators in pollution control lagoons.

Hazardous location. One of the most difficult motors to protect in wet and damp environments is hazardous-location or explosion-proof. The difficulty in protecting these motors arises from several factors. First, due to explosion-proof design requirements, gaskets cannot be used. Similarly, the joints between the end housings and the frame and the conduit box and frame cannot be gasketed or sealed; there must be metal-to-metal contact along these joints. This metal-to-metal contact is close-fitting but, nonetheless — it cannot seal completely. Also, in explosion-proof designs it is not possible to use normal weep holes. Thus, when explosion-proof motors get used in wet environments, moisture that gets inside the motor can accumulate and stay there for extended periods of time. There are breather drain devices that are used in some motors, such as the Baldor 1.15 service factor Class 1, Group D explosion-proof motors. These specially designed breather drains allow moisture to drain from the motor while still retaining the explosion-proof integrity. Again, as in the case of other motors with weep holes, care must be taken to make sure that the breather drains are at the lowest point on the motor.

Some of the options that are available to control moisture in explosion-proof motors are the same as those used in totally enclosed motors. Space heaters can be installed in the motors to keep the internal temperature of the motor above the outside temperature during idle periods. This is an effective way to control the build-up of condensation.

One further key to protecting explosion-proof motors — especially in outdoor situations — is to shelter them from direct rainfall. Again, as in the case of other motors, the sheltering must be done so that it protects the motor but does not restrict the air flow to and around the motor from the outside.

Summary

The installation of motors in outdoor, wet, or damp environments presents some unique problems, but by the proper choice of motor and some caution in installation, most situations can be successfully handled to yield good, long-term operating results. The proper choice of motor enclosure and features, followed closely by the proper location of the weep holes and, in some cases, use of an auxiliary heating device or system to warm the motor during non-operating time, will result in an effective life-extending solution.

Motors such as the Baldor Wash-Down Duty and Severe Duty motors are specifically designed to handle difficult situations. But even when using these specialized products, the basic cautions regarding proper orientation of the weep holes must be followed. **PTE**

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