FRANKLIN AID

Franklin Electric

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

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Keeping the Water Away from the Electricity…

Encapsulated vs Oil-Filled versus Wet-Wound

What was the first thing you ever learned about electricity?

Most likely, it was that electricity and water don't mix.

So, here you are, a water systems professional some years later, doing that very thing. That is, every day, we take an electric motor and put it deep underwater, where the water pressure can routinely exceed 100 psi. Then, we, and our customers, expect that installation to work reliably for many years to come.

So, if you think about it, one of the biggest technical, manufacturing and installation challenges we face together in a submersible installation is keeping the water and the electricity away from each other. However, our industry does a splendid job of meeting this challenge, whether in the drop cable, the splice, the lead, or the motor itself. In this issue of Franklin AID, we'll look at the motor side of things, and the 3 different techniques to keep the water away from the electrical windings in a submersible motor. Each approach is different, and like most things, each has advantages and disadvantages.

To begin with, most submersible motors are "induction run" motors. We'll save an explanation of that for another issue, but the key point is that there is no electrical connection between the stator and the rotor. It's a magnetic interaction, not an electrical one. This means that only the stator contains the motor's electrical windings, and a primary focus of submersible motor design is keeping water away from these windings. As mentioned above, there are 3 different methods of submersible motor construction to accomplish this: Wet-Wound, Oil-Filled, and Hermetically-Sealed.

Wet-Wound

The oldest, least expensive type of submersible motor stator design is what is called a wet-wound design. This is the simplest type of stator construction for a submersible motor, and from a manufacturing standpoint, the easiest. In a wet wound design, the motor windings are actually covered with insulation, usually PVC. There is no inner liner inside the stator, and the entire inside of the motor, including the winding area, is flooded with some type of fill solution. The insulation on the motor windings themselves is what keeps the water and the electricity away from one another.

The advantage of a wet-wound design is that the stator can be rewound. That is, when the stator windings fail, they can be removed, repaired or rewound as necessary, and the motor rebuilt. In some parts of the world, wet wound motors are the only option available.

Although they inexpensive and are rewindable, wet wound motors have significant drawbacks. To being with, wet wound motors are inherently less reliable than other types of designs. Since the integrity of the entire motor is dependent on integrity of the winding insulation, any nick or break in the insulation will cause an immediate failure, and the motor will need to be rewound.

The winding insulation necessary on a wet wound design is also sensitive to heat. Heat is the enemy of any motor, and as a motor operates, the windings become heated. This is measured by what is called "winding temperature rise". The winding temperature rise in a wet-wound motor will typically be 150°F. However, the insulation that covers the windings in a wet wound motor will start to "flow" and break down at around 160°F. Because these two temperatures are so close, there's only a small safety margin from heat damage in a wet-wound design. For comparison, the winding rise in an oil-filled or hermetically-sealed motor (discussed below) is higher, typically around 200°F. However, because magnet wire is used in these motors, the safety margin is much higher. Magnet wire is much more robust, and will routinely tolerate temperatures all the way to 260°F.

Finally, wet wound motors are physically larger that other types of the same rating, either in diameter or length or both. This is due to the insulation on the windings, which makes the winding itself much thicker than the conventional, varnished magnet wire used in most motors.

So, to summarize wet wound motors, they offer a relatively low purchase price, and are simple to build and re-build, but are physically large when compared to other designs and inherently less reliable. Although wet-wound motors are used in some parts of the world, few facilities exist in the United States that can rewind these types of motors, and they have traditionally not held a significant market share in North America.

COMING SOON

Look for a major update to Franklin Electric's Pumptec product in the next few months. The "new" Pumptec will protect your submersible installation even better than before.

This latest version of Pumptec will also allow remote control programming and downloading of pump performance and fault history using a Pocket PC or Palm device.

Look for this exciting new product very soon!

Oil-Filled

The 2 other types of submersible motor designs, oil-filled and hermetically-sealed, both use conventional magnet wire. This copper wire is covered with a varnish, which gives it its characteristic color. This varnish has been specially developed by electric wire manufacturers to provide superior performance in all types of electric motors. It has maximum insulation strength and heat transfer characteristics. But, some way is still needed to stabilize the winding and move the heat away from the winding.

In an oil-filled design, this is done by filling the motor with a food-grade mineral oil. Then, the motor is sealed, generally with some type of mechanical seal at the shaft end. The oil acts as a dielectric, or insulator. The shaft seal is what keeps the well water out of the motor and away from the motor's winding.

Although oil-filled motors can be rewound, their electrical integrity is dependent on the mechanical shaft seal. Whenever the integrity of the seal is compromised by abrasives or even normal wear, the insulating oil will no longer be contained in the motor, and water will enter the winding area, resulting in failure.

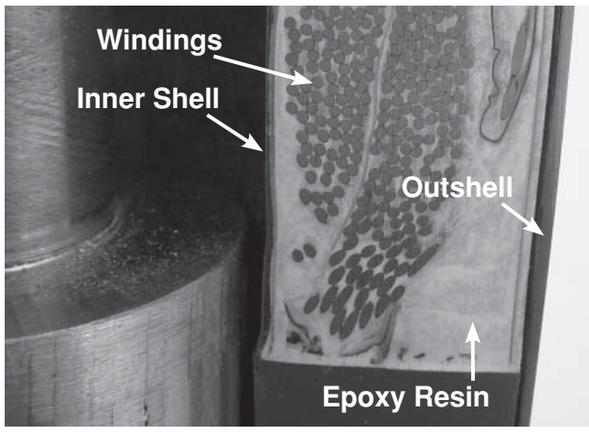
Like the wet-wound motor, an oil-filled stator can be rewound when it fails. Because of this, some regions of the world prefer an oil-filled motor. For these markets, Franklin Electric manufactures oil-filled motors at their facilities in Europe. As a matter of fact, Franklin Electric is one of the world's leading manufacturers of oil-filled, rewindable motors.

Hermetically-Sealed

The most reliable type of submersible motor construction is what is called a hermetically-sealed or "canned" design. Unlike the rewindable designs above, in a hermetically-sealed motor, a stator liner is used, and stator ends are welded to the stator at each end. As a result, the stator and the winding inside are totally sealed from the outside world, hence the name.

Because of its reliability, this is the only type of submersible motor that Franklin Electric builds and distributes in North America. And, although some manufacturers stop at hermetically-sealing, Franklin Electric goes a step further by also "encapsulating" the stator. That is, during manufacture, the stator is completely filled with a proprietary epoxy resin, which totally surrounds the windings. The stator is heat cured, changing the epoxy into an impermeable solid. This process prevents the stator from being rewound, but makes for an extremely reliable stator for 3 reasons:

- Additional insulation – By both hermetically sealing the stator, and encapsulating the windings, the windings are extremely well isolated from the outside world.
- Heat transfer – Franklin's proprietary epoxy resin is thermally-conductive. As a result, it's very effective at transferring heat away from the windings out to the stator shell, where the water flow carries the heat away.
- Stability – One of the issues with rewindable motors is that the windings flex each time they are energized. Over time, this can cause the windings to wear against themselves, and led to failure. When the epoxy cures, it locks the windings in place. This prevents them from ever flexing, so they can never wear against each other.



Cutaway of a Hermetically-Sealed & Encapsulated Franklin Stator

So, there you have it. Three different ways that submersible motor manufacturers keep the water away from the electrical part of their motors. Wet-wound and oil-filled designs offer the advantage of rewindability – Some areas of the world where labor is relatively inexpensive prefer a rewindable motor. However, an encapsulated, hermetically-sealed design provides superior functional quality. This is the market in North America, where quality and reliability are the keys to a good submersible installation and customer satisfaction.

TOLL-FREE HELP FROM A FRIEND

Phone Franklin's toll-free SERVICE HOTLINE for answers to your installation questions on submersible pump motors. When you call, a Franklin expert will offer assistance in troubleshooting submersible systems and provide immediate answers to your motor application questions.

Franklin Electric SERVICE HOTLINE 800-348-2420 FAX 260-827-5102
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