MAKING SENSE OF MOTOR MANUFACTURER CLAIMS

US MOTORS

NIDEC MOTOR CORPORATION

Table of Contents

Introduction: A longer boat isn’t always a longer boat

e-Chapter 1: Thrust bearings: bigger isn’t always better

e-Chapter 2: Bearing cooling systems: They impact thrust capability, too

e-Chapter 3: Interpreting insulation regulations and manufacturer claims

e-Chapter 4: Understanding your insulation system options

e-Chapter 5: VFDs, motor reliability and extended warranties

e-Chapter 6: Making sure your motor specification meets your needs

Introduction

A longer boat isn't always a longer boat – And what that can teach you about choosing a pump motor

If you've ever been in the market for a new boat, you know that manufacturers often use different standards to measure them.

One company may build a 38-foot-long hull, add a two-foot step off the stern and a two-foot pulpit to the bow, and call the boat a 42-footer. Another might label a boat a 42-footer, but it stretches to 48-foot when the add-ons are counted. Such labeling gymnastics can make a big financial difference when you later discover that your "42-footer" needs a 50-foot dock space.

You should be similarly careful when shopping for a vertical motor, where specifications, features and performance standards are also not created equal. Manufacturer claims on everything from thrust and bearing size to insulation treatments and thermal margins can sometimes be confusing, even misleading.

In this e-book, we'll help you cut through the confusion. We'll also pass along some important tips to consider as you choose the vertical motors for your pumping operations.

e-Chapter 1

Thrust bearings: bigger isn't always better

Thrust bearing size may be the single most important factor to consider when choosing a vertical motor for a pumping application. Bearings are important because they must not only support the weight of the motor rotor, but also the impeller set and water column.

But beware: bigger bearings are not necessarily better bearings. It is also possible for two different motors to report the same bearing size, but different thrust. Usually, it is because manufacturers calculate thrust differently. Some include rotor weight in the calculation; others do not.

Bigger bearings also do not guarantee greater thrust. A manufacturer might claim that its thrust bearings are superior, for example, because they are 25 percent larger than the market standard. What the nameplate does not say is that larger bearings produce more heat than smaller bearings. Oversized bearings are less efficient than smaller ones, adding unnecessary losses to the system. They also have higher minimum down thrust, which may be an issue – especially when a motor is run over a wide speed range.

The bottom line: when thrust bearing losses are considered, a motor's actual Full Load Efficiency is often lower than the nameplate specifies.

Because many specifications now call for high-efficiency motors, end-users tend to pay more attention to the Department of Energy-mandated NEMA Nominal Efficiency value stamped on motors than to the more important Full Load Efficiency rating, which represents a motor's actual running efficiency in an application.

Key take-away

The more thrust capability a bearing offers, the greater the efficiency loss. End-users, therefore, don't need more thrust. They need the RIGHT thrust for their application. Rather than gravitate toward the largest bearing size, calculate the amount of thrust you actually need and choose the thrust bearing size that delivers the best performance for your application.

An overdesigned product is rarely worth the added expense.

Nidec's approach

Nidec offers multiple thrust handling options, from standard high thrust to over 300% extra high thrust, and our designs optimize thrust handling and bearing life.

We include rotor weight when calculating thrust, and our motors' Full Load Efficiency calculation includes bearing losses. We use these rigid standards and calculations to provide an accurate reflection of performance and to help you balance performance and costs.

e-Chapter 2

Bearing cooling systems:
They impact thrust capability, too
Thrust bearing size isn't the only variable to consider when calculating the thrust capability of vertical high thrust motors.

Cooling system design also matters, especially as bearing size increases. Larger bearings get hotter faster than smaller bearings, and systems must be designed that effectively remove the heat from them and other motor components.

Manufacturers use different approaches to achieve these results. While some new oil sump designs have emerged in recent years that circulate a cooling agent in and around the motor housing to dissipate heat, most have yet to stand the test of time. Some manufacturers also use water cooling systems as standard on larger motors. But that requirement is not universal, or even ideal. It takes significant investment, however, to install water cooling systems, as well as the equipment needed to supply water to them.

Many of today's best systems are the tried-and-true baffling systems and metering oil solutions with long track records of success.

Key take-away

A vertical motor's cooling system should be designed with the motor's most important mechanical feature – the thrust bearing – in mind.

Nidec's approach

Updated and improved multiple times over the past 100-plus years, Nidec's proven cooling systems use a combination of precisely placed metering paths and oil circulation to produce the volume and pattern of cooling flow needed to achieve even cooling with greater circulation and speed, without requiring water cooling in most cases.

BONUS:
When too much thrust can be an issue

Extra thrust can be an issue on motors with 6800 Frames and larger. But it can impact stock motors as well, particularly those that use a variable frequency drive (VFD).

For certain deep well applications, stock motors use larger axial thrust handling spherical roller bearings that are preloaded to produce greater thrust. But these larger, specially designed bearings call for special considerations. To operate correctly and reliably, they require a minimum thrust.

Because thrust load decreases with speed, it is particularly important to identify minimum thrust requirements when a VFD is used to run a pump at a low speed. This is another reason why it is critical to choose bearings that correspond to the thrust required by your application over the entire speed range.

e-Chapter 3

Interpreting insulation regulations and manufacturer claims

Motor insulation systems are specified by NEMA. But that does not guarantee that two insulation systems of the same class, but from different manufacturers, deliver identical performance, or even that a higher insulation is always preferable to one from a lower class.

This is possible because NEMA considers lead material to be part of a motor's insulation system:

> *NEMA MG1 Standard 1.65.2: Connection and Wiring Support Insulation*
> *"The connection and winding support insulation includes all of the insulation materials that envelop the connections, which carry current from coil to coil, and from stationary or rotating coil terminals to the points of external circuit attachment; and the insulation of any metallic supports for the winding."*

Why does this matter?

Insulation class -- We'll explain with an example. Consider two vertical motors. The manufacturer of "Motor A" may claim it has Class H insulation (which has an insulation rating of 220 degrees, or maximum winding temperature of 220 degrees). The manufacturer of "Motor B" says its motor has Class F insulation (which has an insulation rating of 180, or maximum winding temperature of 180 degrees.) That means "Motor A" has a larger thermal margin than "Motor B" and, in theory, delivers longer life.

This analysis, however, is likely misleading.

First, it's highly unlikely that any standard general-purpose motor's lead material truly has Class H insulation, which would make it very difficult to work with. It's much more likely that the leads have Class F insulation, with a sleeve added over it. While the sleeve provides additional protection, it is separate from the lead itself. It's more accurate to say that "Motor A" has Class H insulation with Class F leads.

Thermal margin – In practical terms, the difference between a thermal margin of 80 to 90 degrees and one of 115-125 degrees is often inconsequential. There's a simple reason why: many of today's premium efficiency motors are designed to run cool. Only a small percentage of special motors need the significant thermal margin offered by Class H insulation.

Key Take-Away:

When in doubt, ask your manufacturer how it defines insulation class – especially for lead materials – listed on the nameplate. Choose the motor with the insulation rating that meets your needs.

Nidec's approach

Because Nidec's premium efficiency motors are designed to run cool, they ordinarily require no greater than Class F insulation. Testing and new technology allow Nidec to validate the robustness of its insulation system, which is specifically designed to validate the ability of the insulation to withstand damaging effects from temperature, moisture and other environmental factors.

e-Chapter 4

Understanding your insulation system options

A motor's insulation system plays an important role in protecting it from moisture, dirt and chemicals, and ensuring its longevity and effectiveness.

Insulation systems involve applying a coating to the winding to prevent dust, dirt, chemical or water from accumulating. This insulation helps extend motor life. Motor manufacturers have several insulation treatment processes to choose from. They fall into three basic categories:

Dip and bake

Dip and bake method is the traditional, time-tested way to insulate a motor. The insulated winding is dipped into a tank of varnish. The saturated components are heated to a defined temperature to cure. The process is repeated, as needed, to meet product specifications. Dip and bake insulation systems are the primary industry method for random windings that are 600 volts and less.

Vacuum pressure impregnation (VPI) – This process involves placing a motor's winding and coils into a chamber and using a vacuum to remove air, moisture and other particles before filling the chamber with resin or varnish. After multiple dry and wet vacuum processes, the winding is removed from the chamber and baked at a defined temperature to cure. The result is a strong, solid structure that reduces coil vibration, increases contamination resistance and improves heat transfer, compared to dip and bake methods. The VPI process is important for form windings that are typically used on motors with voltages over 1000 volts. Form windings utilize taped wires that the varnish impregnates during the vacuum process. The tape is impregnated with the varnish to provide increased strength and protection.

Trickle treat –Trickle treatment involves applying a thin stream of resin to baked windings and coils in a controlled process. Because it results in less waste than dip and bake or vacuum pressure impregnation, it is considered a better manufacturing process. It also needs less cure time because no excess resin/varnish must drip off. Trickle treatment produces an even insulation coating that fills air pockets.

Given its limited track record, trickle treat is not specified as frequently as dip and bake or vacuum pressure impregnation. Dielectric qualities are comparable to those of dip and bake.

Key take-away:

Any of the three insulation methods can be specified for vertical stock motors, based on customer preferences. The important thing is to select the method that will protect against the environment in which a given motor will be installed. The most robust solution may not be necessary; bigger is not always better.

Nidec's approach

Nidec insulates its premium efficiency motors using the dip and bake and vacuum impregnation methods, according to a customer's specifications and motor size. Smaller motors can operate reliably with simpler dip and bake solutions. As motors get bigger and windings increase, VPI becomes a better standard option.

e-Chapter 5

VFDs, motor reliability and extended warranties

Variable frequency drives (VFDs) are used to change motor speed and maintain peak efficiency when output demand changes. Demand for specially designed VFD-rated motors has grown in accordance with more stringent industry requirements for higher efficiency variable speed solutions. Many people believe that most pumping system reliability problems are caused by a malfunctioning VFD or motor. In reality, pumping system problems can most often be traced to improper installation.

Installers often don't understand how to protect a motor from the potentially harmful effects a VFD can produce, or how to reduce these effects in a pumping system. Extra protections are key. If your motor is malfunctioning, ask these questions:

1. Are the motor and VFD grounded properly?

The motor will not be completely protected if it alone is grounded. The VFD produces high frequency current that needs to be grounded back to the drive as well. That involves more than running a cable back to the common ground on the drive. The motor should be grounded back to the drive using a braided type of grounding wire that is, at minimum, the same size as a single power lead and runs in the same conduit as the power leads.

2. Are you using the correct cable and running it properly?

The power cables that run from the VFD to the motor should be shielded and specifically rated for use with a VFD. Check with your supplier to ensure they are the recommended size for the system's voltage and current limits. Cable that is too small or improperly shielded can damage a motor. Also, the conduit used to house these power leads and grounding wire should be metal, and it should be connected to both the motor and drive without isolating either.

The distance between the motor and drive matters, too. As the distance increases, the damaging effects are amplified. While it's common to locate a VFD on one floor and the motor on another, you are wise to locate them in as close a proximity to each other as possible.

3. Does the power entering the motor experience spikes or voltage differentials?

Motors that operate with VFDs are specially designed to be operated when powered by a VFD's pulse width modulated (PWM) power waveform. While a very efficient method of motor speed control, a PWM wave form can, among other things, cause a motor winding to experience voltage spikes that are well above the rated voltage of both the motor and standard motor winding limits.

To protect against voltage spikes, these motors require additional winding protection. According to NEMA MG1 Part 31, motors with a voltage rating of 600 volts or less that are used on VFDs should have windings that protect, at a minimum, against a voltage spike of 3.1 times the rated voltage. For motors with a voltage rating greater than 600 volts, the minimum is 2.04 times the motor's rated voltage.

4. Are the bearings protected with shaft grounding?

Windings are not the only component of a motor impacted by PMW waveforms. An electric motor's bearings must also be protected from the charge imbalance that can build up between the rotor and stator due to PWM waveform. Known as Common Mode Voltage (CMV), this differential charge needs to be balanced to prevent motor damage.

If the bearings are not isolated from the shaft and the system is incorrectly grounded, the bearings provide the path of least resistance that a motor seeks to balance the charge. When this balancing happens within a bearing, pieces of bearing material can dislodge while the motor is running, which can severely damage the bearing, or at least cause noise, heat and premature failure over time.

One way to prevent the CMV phenomenon is to give the motor a low resistance path to ground to balance the charge between the rotor and stator. This is commonly achieved by adding a shaft grounding device to the motor and grounding the motor. On larger motors, additional protection can be gained by insulating the bearing opposite the shaft grounding ring to eliminate circulating currents.

Key take-away:

Operating problems on pumping systems with VFDs can most often be traced to improper installation. As a result, an extended warranty on a motor does not mean that motor is more reliable or will have a longer life. The best way to achieve a reliable, robust and a long-running variable speed pumping system is by designing and installing the motor and VFD as an integrated system. If the motor is grounded back to the drive, and the wire, conduit and filter are correctly sized, the result should be a variable speed drive system that runs to specification. Motors that are improperly installed have a higher risk of failure.

Nidec's approach

Because Nidec cannot predict where, how or when its components will be installed, we add extra protection for windings and bearings as standard features on our vertical motors that will be installed with VFDs. We include these protections because we don't want motors to fail in the field.

e-Chapter 6

Making sure your motor specification meets your needs

Most end-users of pumping systems are not motor experts. They rely on the expertise of others to specify motors and other products that address their needs.

Many motor issues arise because the specifications created either aren't clear or don't reflect the actual needs of the end-user. Other problems result due to bidding battles, with one supplier offering a product it claims is "close enough."

Your pumping application will be best-served if your specification receives a full review by an informed engineer who can identify areas of incompleteness or ambiguity to ensure the design and features you receive will deliver the performance you expect.

The topics that should be considered include:

- Efficiency at full load, considering bearing loss
- Thrust calculations
- Heating with larger bearings
- Minimum thrust requirements
- Oil circulation and cooling systems
- Electrical system design and reliability
- Ease of connecting the motor to a pump stand
- Clearly defining accessories when specified

Key take-away:

Know what you are buying, and be wary of new, unproven designs. If you are told a solution is "close enough," that is no guarantee that it actually meets your specification. Always ask an expert to confirm if and why a motor meets the spec.

Nidec's approach

Nidec maintains multiple teams of professionals dedicated to reading customer and end-user specifications to make sure the quoted motor addresses the end-users wants and needs. A dedicated engineering team is responsible for inquiries regarding electrical designs and special features, and district sales representatives meet directly with customers to help ensure proper motor selection.

Nidec currently has more than 2,500 vertical motors in the inventory of its three primary U.S. warehouse locations. These motors range from 15HP to 600HP, TEFC and WPI, and include thrust handling options for a wide range of applications. Our warehouses also offer conversion centers for faster turnaround of simple standard features and options for bases, couplings, space heaters, thermostats and more. Our SINEWAVE OPTIMIZED® line for constant speed operation and INVERTER DUTY line for use on VFDs is also available.

NIDEC MOTOR CORPORATION