Diagnosing the Health of Medical Motors

Brushless motors proving to be the cure for the common medical device

Erik Schmidt, Assistant Editor

John Morehead, national sales manager of Crouzet Motors (Vista, CA), was bunkered down in his office in Palatine, IL surrounded at all points by ankle-deep snow from an unfortunately terrible Chicago's winter night. After a polite pardon, he removed himself briefly from conversation for a quick refreshment to clear his throat.

Once a safe distance from the receiver, Morehead coughed heartily for the umpteenth time, sending a muffled squawk through the mouthpiece, and then revealed information that any solid sleuth would have found quite elementary.

"I'm coming down with a bad head cold," he said.

The topic of discussion that icy afternoon: motors being used in medical devices.

How very fitting.

Motoring Forward

True, there is no application for a motor to cure the common cold. So, despite Morehead's deep knowledge on the subject, he was simply going to have to overcome his ailment the old fashioned way — with a bag of Halls and ceaseless patience.

While Morehead himself was stuck in phlegmatic purgatory, countless hospital patients across the world were being aided by machines powered by Crouzet motors.

Unpoetic justice, perhaps. But you won't see Morehead complaining about the positive development.

"We're seeing more and more applications in the hospital for motorizing tasks that were before done with human power," Morehead says. "I think part of that — I saw a study on this — is that the average age of a nurse in the workforce today is something like 52 years old. There's just so much more for them to do."

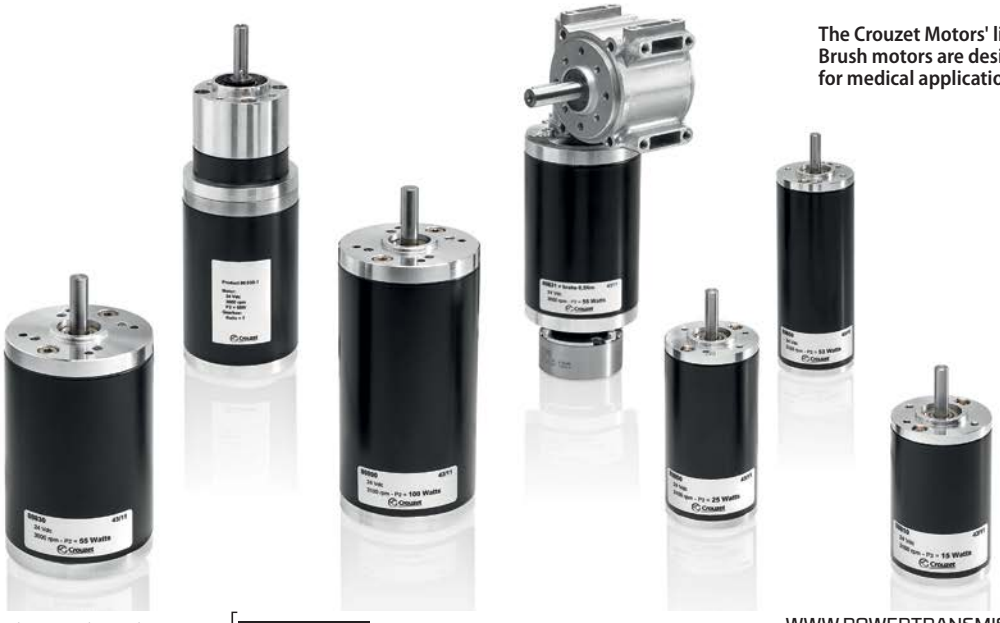
And that's where motors come in.

More and more, the world is becoming motorized and automated — and hospitals are no exception. Brushed direct drive motors and brushless direct drive motors have been used for years to power diagnostic equipment, blood and DNA analysis machines, and peristaltic pumps. In recent years the demand for motorized medical equipment has only grown.

"How many electric motors do you think you have in your home?" asks Dan Jones, president of Incremotion Associates, Inc. "How about 60 on average. How many motors are on an automobile? There's about an average of 30 to 40. If you didn't have them your windshield wipers wouldn't work, your windows wouldn't go down, and your seat wouldn't adjust.

"Motors are so ubiquitous that nobody thinks about them until they have a problem."

That "problem" in regards to the medical profession was posed by Morehead as such: "How do we take



The Crouzet Motors' line of DCmind Brush motors are designed specifically for medical applications.

away the workload of nurses and allow them to be more productive?"

The most prominent way that motors help in this process is their utilization in various medicine-administering pumps, such as a peristaltic pump — a type of positive displacement pump used to pump sterile or aggressive fluids because cross contamination with exposed pump components cannot occur.

"They're used in dialysis machines and a lot of other areas," Morehead says. "For example, when someone is going into a dialysis center they may be injected with what's called Venofer iron. That's put into the bloodstream before the kidney dialysis, and a vial of the Venofer takes about five minutes to inject by the nurse.

"One of the customers that [Crouzet] works with has a product that is an addition for the dialysis machine, so it's able to administer the Venofer iron with just the nurse doing the initial injection. This frees up the nurse for the five minutes she might be standing there otherwise manually doing the entire process."

According to Morehead, other innovations in recent years include making motors more discreet, mobile and efficient.

"It boils down to a few key words: quieter, conserving, controllable and connected," Morehead says about the current state of medical motors. "Basically, we're seeing more and more interest in quieter motors in the medical market, and the interest is heightened even further in the operating room where there is an especially strong incentive to reduce high-frequency noises.

"On the conserving side, it's in reference to energy efficiency and battery-powered equipment. When you're looking at devices that are portable, energy efficiency becomes very important so that you can get the greatest running time between charges for the equipment.

"Controllable is the fact that people are wanting to operate equipment at varying speeds and at the speeds that are required by the task at hand.

"I think that plays into what we're seeing with the brushless motors a lot."

Brush it Off

Since the dawn of Homo erectus, the brushed DC motor has been aiding two-legged primates tackle the enormity of the planet earth.

OK, so maybe not.

Brushed motors don't actually date all the way back to the days of cave paintings and Oldowan stone tools, but close — DC distribution systems were used for more than 100 years to operate motors in commercial and industrial buildings.

A brushed DC motor is an internally commutated electric motor designed to be run from a direct current power source. They're economical, but also noisy and often in need of maintenance because the brushes wear down due to friction.

Slowly but surely, the brushless DC motor — also called the direct drive

motor or the electronically commutated motor—has begun displacing brushed motors in many applications.

And in terms of effective usage in medical devices, brushless DC motors have been a natural fit.

"Brushless motors have been around a long while. It's just that it takes a long time to percolate to various locations," Jones says. "The brushless motor is the best motor for torque and the smallest motor for performance power for power, so it has a lot of advantages.

"It's linear, where induction motors are not, so you have more current and get the torque you want. You have more voltage and you get more speed. It's better and it's easier to control—so people are figuring out a way to use it."

Brushless motors became commercially available in 1962, but were not widely used in medical devices until about 15 to 20 years ago, according to Morehead.

A typical brushless motor has permanent magnets which rotate around a fixed armature, eliminating problems associated with connecting current to the moving armature. An electronic controller, which continually switches the phase to the windings to keep the motor turning, replaces the commutator assembly of the brushed DC motor.. The controller performs similar timed power distribution by using a solid-state circuit rather than the commutator system.

"It used to be that you could buy a brushless motor and then if you were to buy a control to operate that motor and vary the speed, the control might cost as much as the motor," Morehead says. "That control was typically on a separate circuit board on a bracket or in a small enclosure that was separate from the motor.

"I would say that in the late '90s, early 2000s time frame, the state of electronic development advanced to the point where you were able to reduce the size of the control. The other part of that was in order to get electronics to live, you had to be able to isolate the electronic components from the heat that would be produced by the motor. Some of the early ventures to try to do that were kind of short lived, because

they would put a control board on a motor generating heat and get premature failure on the component.

"The thing was to figure out how to properly isolate and provide the right thermo-barrier there. I would say in the last five to eight years, there's been a big growth in brushless motors with integral electronic controls. In some instances, that control can be used to vary the speed of the motor and can use various IO, as well. More recently, that control capability has gone to positioning controls, so basically you can have the equivalent of a servo drive all on the motor.

"That's really become an important growing area. It's a much higher value component."

Brushless motors are used in CT-scanners and equipment related to opening protective barriers in medical environments such as an x-ray room, but it's their use in various pumps that seem to be having the most influence in the medical field.

"We tend to see, in terms of the types of motors [Crouzet] produces, a lot of interest in changing the type of motor used in various pumping applications," Morehead says. "Some of the motors we make are used in various surgical procedures where the motor is pumping a saline solution that provides a kind of lubricant while the procedure is being done.

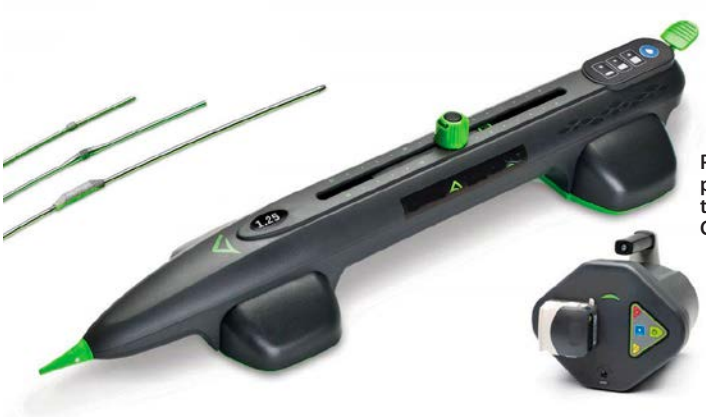
"Of course, in all of this, the big thing is reliability and the lifetime of the product."

There is no doubt that brushless motors represent the future. For a moment, though, let's travel back to the dark ages and posit a question:

Do brushed motors hold any sway in today's world?

The answer according to Morehead: thanks to Crouzet, they certainly do.

"I sound kind of boastful, but there haven't been any real significant developments in brushed DC motors in probably 25 years," he says. "[Crouzet's DCmind Brush] is one where we do feel like it's pretty significant, because of the noise being reduced from something like 60 decibels to 34 decibels, and the increase of life can be three times longer or more.



Pictured is an arterial plaque removal system that uses motors from Crouzet Motors.

"The DCmind Brush is probably the most innovative product on the market on the brushed side."

On the brushless motor side, Portescap recently introduced a new addition to its Ultra EC mini motor platform — the 16 ECH brushless motor. According to a press release, the 16 ECH was designed specifically to provide an economic motor solution for high performance applications. It's specifically optimized for high continuous torque at low to medium speeds, maximizing power between 40 K and 55 K rpm, and rated speed at approximately 60 K rpm.

The advantages of the 16ECH make it a great match for low speed, high torque end applications, or applications in the medium speed range (30 K to 55 K rpm). The 16ECH is a good choice for geared applications because of its minimal speed drop and low motor heating under load. Additionally, the 16ECH's efficiency, power density and long life make it an alternative for a brush DC motor solution, the press release said.

A Quick Look through the Crystal Ball

Now that we've touched on both the past and present of medical motors, you may be asking yourself, "But what of the future?"

Morehead said it's closer than you may think.

"I think one thing you'll see more of is the magnetic pump drive for gear pumps," Morehead says. "There aren't many companies who are doing that and we're a player in that. We're actually making a brushless motor without any [internal] moving parts.

"It's a brushless motor with variable speed control mounted to it, but there's nothing rotating within the motor. Rather, instead of the rotor rotating like it would in a regular brushless motor, it's replaced by a magnetic cylinder that couples to the gear pump. Therefore, the gear pump is able to operate without any seal so there's no leakage or contamination.

"This makes for a more precise dispensing and calibration than you would have with a typical peristaltic pump."

Looking through his crystal ball, Morehead saw that these magnetic pump drives would be a prominent fixture of the medical market in the next several years.

And, presumably, he also saw himself healthy as a horse, devoid of any nagging head cold or annoying throat condition.

Either way, it would seem that happy, healthy days are surely ahead. **PTE**

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