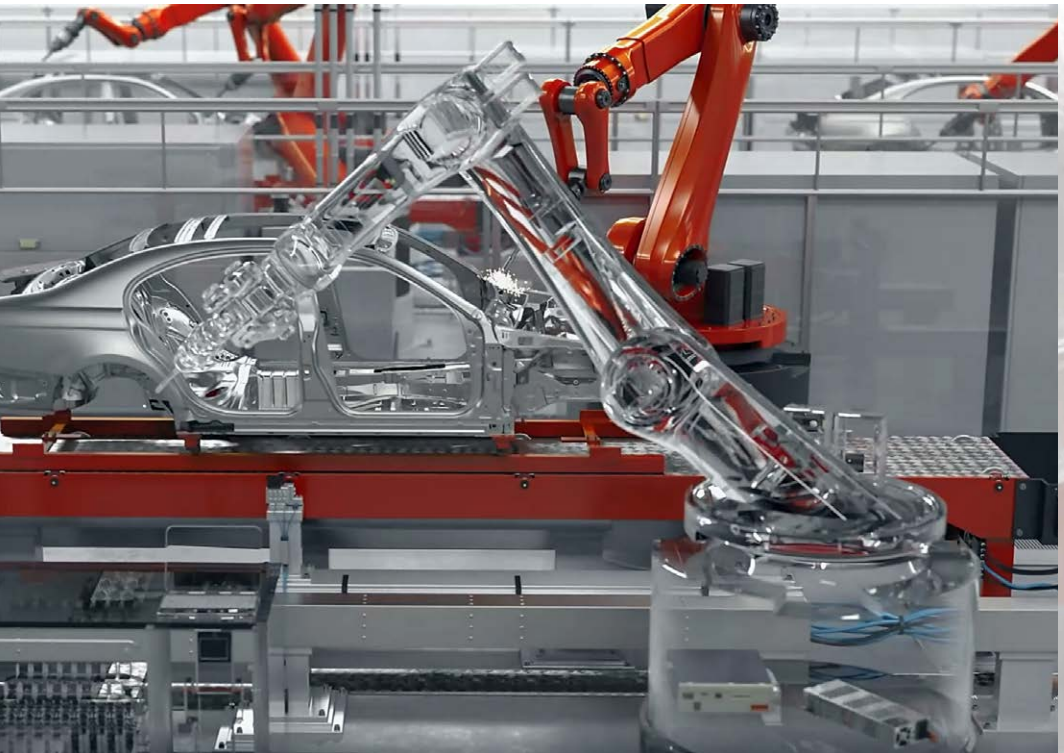
ELECTRIC MOTORS KEEP THE WORLD SPINNING

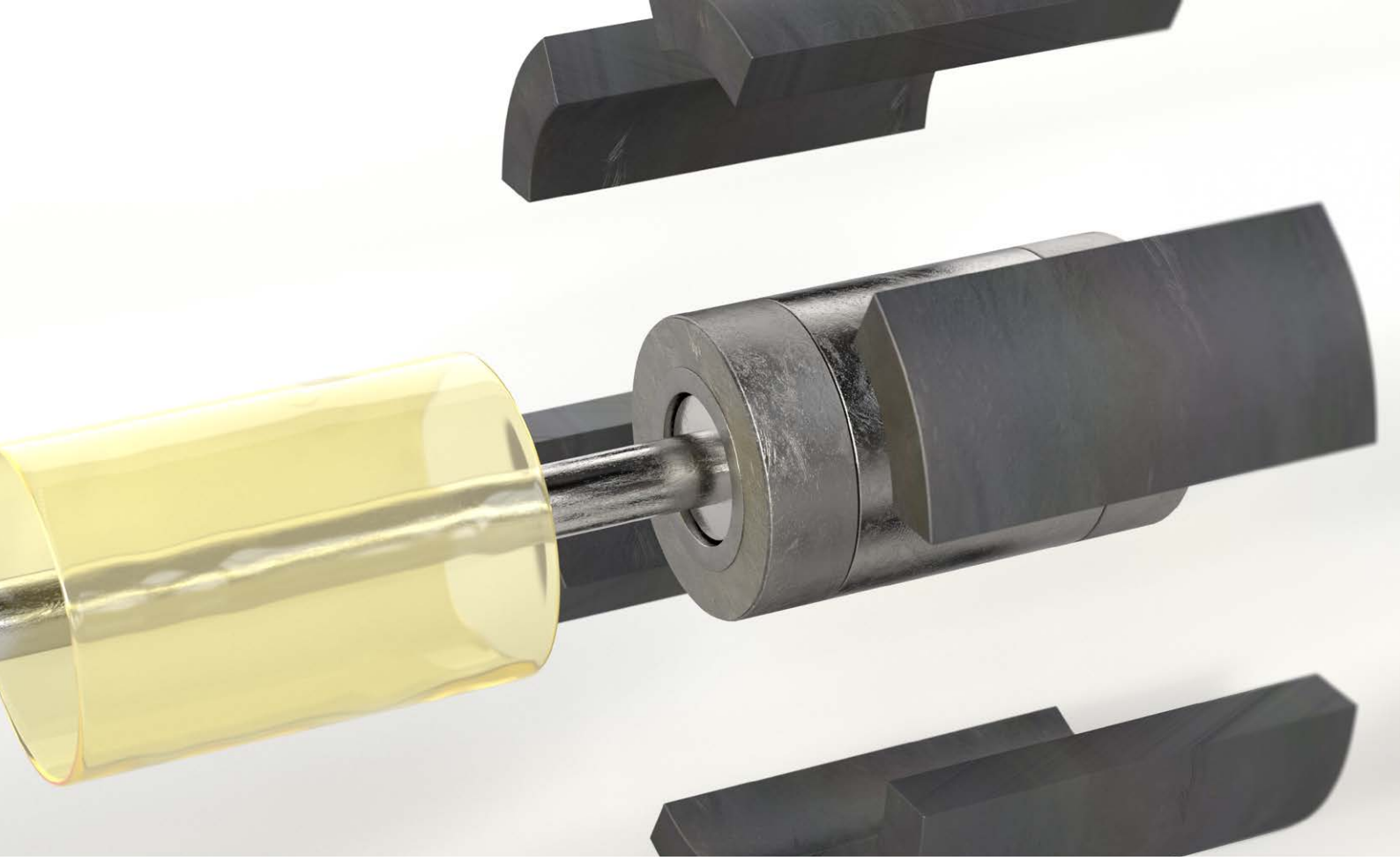
Adhesives Make them More Reliable and Efficient

Robert Dunkel

Ever thought about what enables your vacuum cleaner or washing machine to work? How your home is heated and cooled? Or how that phone or PC is assembled? Electric motors help make all those things possible. They're everywhere. Electric motors are throughout the appliances in your home. Anywhere there is a pump or compressor, an electric motor is present. Motors power HVAC systems in residential and commercial spaces. And, of course, electric motors are at the heart of industrial smart factories worldwide. On any manufacturing line where parts are being transferred from one station to another and assembled, electric motors create that movement – of conveyor belts, robotics, and nearly every type of machinery.

One could argue that electric motors are some of the most – if not the most – essential tools of our modern existence.





Market Forces: They're Magnetic

Electric motor designs are as varied as their end applications. There are direct current (DC) and alternate current (AC) motors, and all shapes and sizes depending on the use, the torque required, and the operating conditions. However, the basic concept of the electric motor and its primary electric and mechanical components have remained relatively consistent since inception. What has changed are the designs and materials used to build them. Like most products, innovation has enabled electric motors to become lighter, more powerful, and less costly. And that's a good thing because cost-efficiency leads to application proliferation. The result is more motors for more end uses.

With motors in innumerable consumer goods and automation fueling industrial innovation, electric motor growth is set to explode during this decade. According to analyst Allied Market Research, electric motor revenues are projected to double during the 2020 – 2030 forecast period, topping **$207 billion globally**. Advancing energy efficiency, reliability, and longevity will help continue the accelerated pace of motor evolution and market expansion.

While electric motor innovation encompasses several factors, magnet design, and assembly methods are areas of particular interest. Magnets are central to electric motor function, creating a proper magnetic field to generate force. Attaching – or bonding – magnets to the motor's stator and rotor, and the method used to do so is also part of the electric motor efficiency, reliability, and overall performance equation.

Historically, mechanical clips or screws were used to hold magnets in place. Today, that bonding method has largely been replaced by adhesives, and for good reason. Actually, for several good reasons, as highlighted below:

EFFICIENCY

Adhesives enable a more competent solution to bonding – from storage to production to operation. Deposition volumes, bond line thicknesses, and patterns can be adjusted to align with various motor designs and magnet shapes; adhesives are thin and lightweight for more energy-efficient motor operation; and integrate with mass production techniques.

RUGGEDNESS AND RELIABILITY

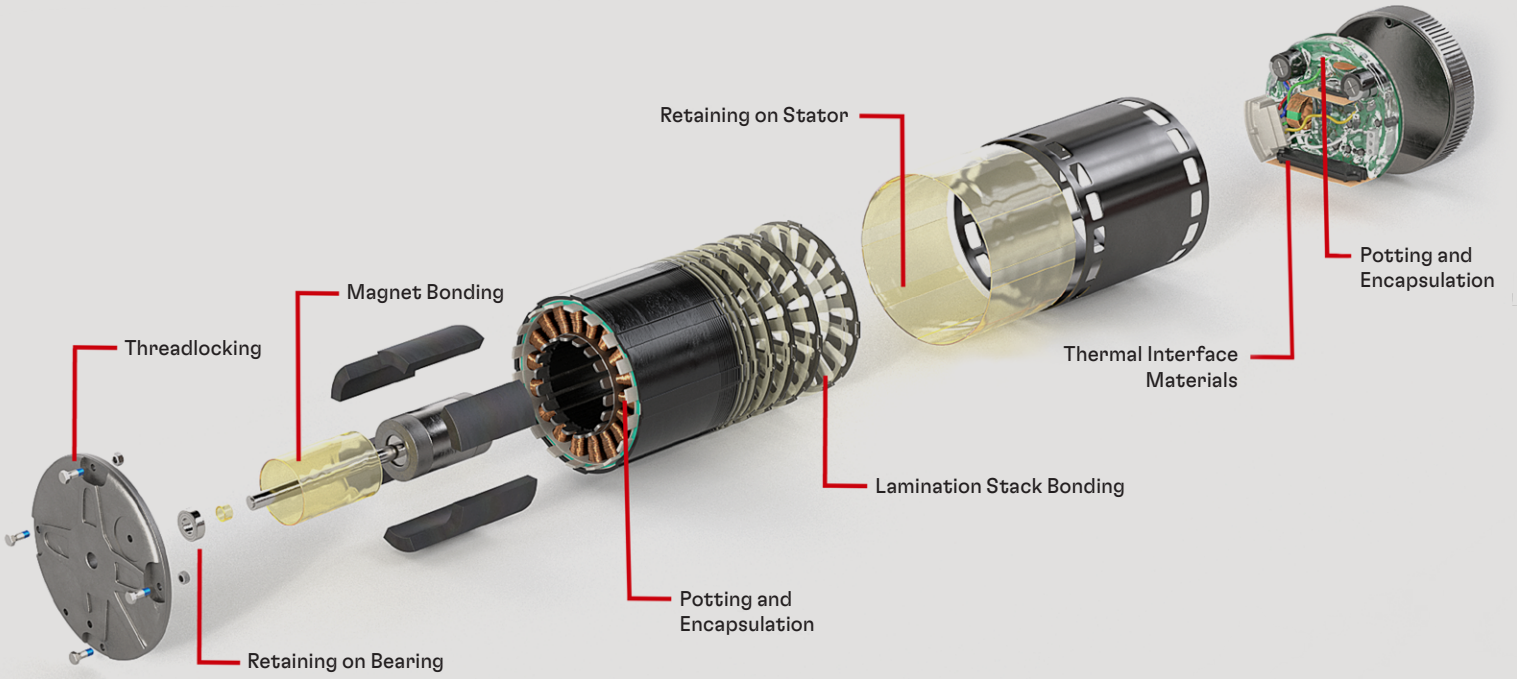
Magnets are expected to never fail, and they usually don't. If a motor fails, the magnet is generally not the culprit. The magnet bond, however, could be the cause if not secured with the ideal material. Mechanical solutions (screws and clips) are more susceptible to vibration, as are some adhesives. So, selecting an appropriate material for the application will ensure long-term durability.

SUSTAINABILITY

Adhesive use in electric motors conserves resources, reduces manual labor requirements and, because their long-term strength adds reliability to the assembly, the materials help extend the useful lifetime of the motor. This, in addition to new developments in adhesive chemistry innovation using biobased raw materials, delivers a sustainable solution.

DESIGN ADAPTABILITY

Electric motor designs are becoming more sophisticated and complex; adhesives allow this transformation to flourish. They adapt to various designs, different chemistry platforms open endless options, and adhesive formulations can join many dissimilar surfaces. The possibilities are endless.



Material Selection

Though electric motor magnet bonding adhesives are now viewed as a superior solution to mechanical joining, choosing the most suitable material may not be as simple as it sounds. With nearly as many adhesive options as there are electric motor designs, tapping into the expertise of a supplier partner with deep knowledge – not only of adhesives, but also of motor design, end-use environment, and operational conditions – is important. Material selection considerations include:

Vibration
All motors have some level of vibration, some more extreme than others. Adhesive testing with those that have more demanding requirements is essential, though duplication of years of service estimates can be challenging. There are several standard and custom approaches to evaluate adhesive durability and adhesion strength under stress.

Temperature Extremes
Electric motors are expected to operate for a long time and must withstand harsh conditions. Motors generate heat, and are often required to work in inherently hot environments. Operating temperatures of 100°C – 150°C are common and can be at the limit of many adhesive chemistries. Hot strength evaluation via a simple push-out test following specified temperature exposure provides first-pass screening in the adhesive system, followed by more in-depth testing of promising candidates. Predictive modeling analysis helps gauge durability for length of service expectations, and Henkel has in-house capabilities to assist with this testing.

Moisture and Humidity Exposure
Moisture – especially with high heat – tends to degrade components more rapidly. In the electronics field, the standard test is 85° C and 85% relative humidity for 1000 hours to verify performance. It illustrates that humidity combined with heat is far more challenging than if tested separately. There is no exact parallel to this test in the electric motor field, as each manufacturer designs testing based on the end application environment and considers these factors in adhesive selection.

Insulation
Adhesives that are used for magnet bonding in electric motors are not electrically conductive, and electrical insulation is not required. However, the materials do fill the empty space due to tolerances and this improves the magnetic flow within the motor.

Production Volumes
Production volume is a key consideration for adhesive material specification. Automation requirements influence the optimal adhesive system selection, and line speed dictates factors such as fixture and clamping time. Adhesive rheology also plays a role, as part orientation (vertical or horizontal) during assembly may require specific adhesive properties. Cure profile is another determining factor. Curing that takes hours or days leads to excess inventory. Room temperature cure adhesives that fixture quickly help minimize work-in-progress inventory.

Substrate/Housing Materials
Magnet materials have become more lightweight and varied, offering design latitude to engineers. Adhesives have facilitated this transition, enabling bonding to almost any surface to allow selection of application-tuned motor components. Adhesives are compatible with nylon, magnesium, steel, aluminum, most plastics, and any combination thereof.

Thermal Control
The continuing trend of higher function and smaller geometry increases operating temperatures and the need for effective heat management. The primary function of the adhesive is bonding, but certain motor designs may also require thermal transfer capabilities. An adhesive between two parts – versus an insulating air gap – aids in thermal transfer, moving heat out of the motor and providing improved durability. Henkel is a leader in thermal interface materials development and can modify adhesives for improved heat transfer. This is especially import for on-motor circuit boards and variable speed controllers.

Henkel has partnered with electric motor innovators for over 50 years, helping to facilitate new designs, scale production, and bring novel products to market. A portfolio of adhesive chemistry platforms, including acrylic, cyanoacrylate, epoxy, MMA, polyurethane, and silicone have supported the manufacture of reliable, high-performance electric motors in markets ranging from sophisticated smart factory equipment to agriculture machinery to common household appliances. Experience, global capability, and innovation matter – Henkel has them all to help keep our customers moving forward.

Robert Dunkel

The Author

Robert Dunkel is a Licensed Professional Engineer and is currently a Senior Principal Application Engineer for the Industrials business unit of Henkel Adhesive Technologies. Over 30 years of experience with multiple product lines and technologies exposed Robert to various adhesive system types and applications. In his previous role as global lead for customer technical call centers operating in the Americas and China, he was the primary decision-maker for customers' most challenging applications. This valuable experience helped him become a champion of the company's knowledge management systems to ensure long-term organizational sustainability.

In his free time, Robert is passionate about repairing things using adhesives to deepen his understanding of bonding solutions and the natural boundaries of technology. Based in Canada, Robert holds a bachelor's degree in manufacturing engineering from McMaster University (Hamilton, Ontario).

Explore More:

Read some of the use cases:

- *Retaining Adhesive Helps Improve Electric Motor Performance and Extend Lifetime*
- *Structural Adhesive Enables Reliable Motor Performance in Challenging Environment*

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