Rotor Manufacturing

Understanding rotors is key to saving maintenance dollars

When it comes to electric motors, rotors are one of those critical components that have to be in top condition for a motor to operate effectively. If a rotor fails or is malfunctioning, it needs to be either repaired or replaced. If you've just gotten word that the rotor on one of your facility's motors has gone out, here is the information you need to make an informed decision on what to do next.

Quick Review of Rotors and Stators

Two of the most basic parts of an AC electrical motor are the rotor and the stator. The rotor, as the name sort of implies, rotates; the stator, on the other hand, remains stationary. In order to understand how the rotor works, you also need to know about the stator.

The stator looks is a hollow cylinder made up of electromagnets positioned so that the pole of each magnet faces toward the center of the group of magnets. The rotor is mounted on the motor shaft and located within the stator with an air gap between the stator and the rotor. Like the stator, the rotor is also comprised of electromagnets, abut these magnets face toward the stator poles. Interactions between the magnetic fields of the rotor and stator cause the rotor and motor shaft to turn.

There are quite a few components to a rotor, but there are three specific parts that are the most important: the rotor bars, the rotor ring, and the laminations. The rotor bars are responsible for carrying the induced current caused by the stator.

What Causes Rotors to Fail

Rotors eventually wear out, and their life can be shortened by contamination, heat cycles, and similar issues. When a rotor fails, it is more often than not traced back to the rotor bars. Rotor bars suffer the most wear and tear when the motor is started frequently (and this is made much worse when the load is full or excessive). Rotor bar fractures, ring fractures, rotor bending, and

imbalance are all common forms of rotor failure. However, there are other things that can fail, and they can pretty much be traced back to the rotor bars.

Why Rotor Repairs Are Not Always Recommended

Sometimes, repairs to a rotor are not recommended or simply not possible. In some cases, the rotor may have been manufactured based on an outdated design and there are modern alternative rotor designs that would increase performance and reduce downtime. In other instances, it could be that repeated repairs over the years have weakened the overall rotor's performance (e.g, it has simply been repaired too many times). In other instances, the technicians might have noticed that the rotor simply has a very poor design that is not worth repairing. Something else that can happen is discovering the bars or rings use copper alloys that are no longer readily available. However, all of this depends on the rotor in question.

Manufacturing Parts for the Rotor

The key parts that must be manufactured for a new rotor are the bars, rings, shaft, and laminations. However, the materials used for these parts are almost as important as the part design itself.

Material Evaluation and Selection

One of the important decisions regarding the manufacturing of a new rotor is selecting the right alloy to be used for the bars and rings. While copper is the most common material used for these materials, aluminum is used on smaller machines. When repairs are performed, it is normal for the repair shop to perform a conductivity test or chemical analysis on the bars and rings to evaluate the chemical composition of the material to obtain a close match. The laminations are typically made from a specialty insulated steel alloy.

Rotor Bars and Shorting Rings

Rotor bars must be made to precision specifications that include mechanical, dimensional, and chemical properties. The same is also true of the shorting rings, which are more complicated to manufacture because of their shape. The

initial shape of the shorting ring is usually obtained by casting (including vertical, horizontal, and cylindrical casting) or by shape forging.

Shafts

Most rotor shafts are machined from a high-quality steel alloy, but for best performance, AISI 4140 or 4340 steel is used and typically heat-treated. The heat treatment is used to achieve a certain depth of hardness and overall shaft strength as well as to refine the shaft so that it has proper crystalline microstructures.

Laminations

Laminations are typically an insulated steel alloy and their initial shape is formed by a stamping process although laser cutting may be used to achieve highly precise dimensions.

Final Shaping

The final shape for both bars and rings is obtained through precision machining. Note that shape forging is recommended for applications that involve severe duty conditions or high RPM.

Rotor Manufacturing Process

Here is a quick overview of the sequence of steps involved in the manufacture of a rotor:

- Casting of bars and ring
- Stamping or laser cutting of laminations
- Inspection of individual parts
- Stacking, staking, and skewing of laminations
- Bonding
- Brazing
- Final assembly
- Dynamic balancing
- Final inspection

HECO Manufactures Rotors

Not only can our technician's at HECO troubleshoot and repair rotors, but we can also design and manufacture a customized rotor to fit your needs. We can evaluate and redesign to your existing rotor to achieve better performance and significantly less downtime using the latest industry standards. In fact, we specialize in engineering new induction rotor designs for problematic applications. Typical design changes include improvements to the rotor bars, shorting rings, shaft, and laminations. Among the key factors that we consider are the stator and rotor magnetic circuit calculations, thermal temperature rise calculations, startup load inertia calculations, and the copper alloy electrical conductivities. No stone is left unturned as we evaluate existing designs and improve upon your rotor design.