

Proper Maintenance and Upkeep in DC Motor Units

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When cared for correctly, direct current (DC) drives, motors, and their controls can offer excellent reliability over a long service life. They have a number of other benefits when properly maintained in addition to long service life including; relatively low operational costs, a low overall weight, and simple operation. These motor units are widely used across a range of sectors including aerospace, mining and power generation.

Proper care for DC motor units primarily consists of regular, thorough inspections, with a focus on the following priorities: long commutator service life, minimal arcing and destructive sparking, and increased carbon brush life. Regular inspections prioritizing these three goals, and adequate maintenance work, will ensure that DC motor units perform reliably in the long term.

Perform regular inspections

Appropriate inspections are at the heart of successful DC unit upkeep. Inspections give operators visibility of motor unit condition, encourage timely repair and preventative maintenance work, and provide a regular source of information for reference throughout the motor service life.

The recommended frequency of inspection depends on the motor unit use conditions. Though this time frame can vary from application to application, the priority is to adhere to regular inspection periods to monitor performance. Whether your application calls for monthly, quarterly, annual, or otherwise timed inspections, setting and following an inspection schedule closely is critical to reaping the benefits of inspection. This schedule can be adjusted based on motor unit usage, the individual unit's criticality, or other conditions that may affect motor service life.

Successful inspections include visual assessment of the motor unit with data recorded in the form of detailed notes for future reference. Operators concerned with worsening commutator conditions may also photographically record their inspections for accurate comparison between inspections.

Two types of inspections can be very valuable, an operational inspection and a static inspection. The operation inspection reviews commutation (sparking levels), air temperature and any unusual vibrations. The static inspection focuses on cleanliness, brush wear, brush wearing signals, signs of overheating, commutator film evaluation and spring condition.

Assessing commutator condition

Maintaining the condition of the commutator is the most important aspect of DC motor unit upkeep. The creation and maintenance of an acceptable brush film, as well as the avoidance of metal transfer, burning and other destructive conditions, are key to ensuring the commutator's condition.

Brush films are formed by the gradual, but expected, degradation of carbon brushes and the mixing of the resulting carbon dust with humidity and small amounts of copper from the commutator. An ideal brush film allows the commutator to continue spinning smoothly, without being damaged by the brushes, while still effectively transferring power to the motor. Though it is commonly believed that commutators' brush film must be "chocolate brown in color with a medium polish" in order to be considered normal, there are in fact a number of acceptable commutator conditions, as well as several conditions that are concerning but not critical.

In fact, the most common type of commutator film type is not a uniform film but rather a blotchy, non-uniform finish. Accumulated tolerances in the motor unit such as commutator roundness, brush contact pressure, unequal magnetic fields, and chemical vapors are all possible factors in the development of the film appearance. This type of film, in addition to being the most common, is a completely acceptable filming pattern.

Commutators with uniform films of any color are also acceptable for use. Film color is a result of brush composition, impregnations and processing, and so motors utilizing different brush grades will display different film shades.

Slot bar filming, where a repeated pattern of dark and light films related to the number of armature coils per slot occurs, is the final type of fully acceptable film pattern. Slot bar filming results from machine design and is not usually impacted by brush grade.

In addition to these acceptable film conditions, streaked films or films with bright spots are concerning, but not themselves unacceptable. Streaking of only the film is not detrimental to the commutator; however, if metal transfer develops, streaked filming can progress into threading, an unacceptable commutator condition. Similarly, bright spots on an otherwise dark commutator film indicate that the machine is likely subject to frequent overload cycles. If the bright spots disturb only the film, the machine can operate under this condition for long periods of time. However, if severe metal transfer begins, the bright spots could become bar burning or film stripping, both of which are unacceptable commutator conditions. Commutators with concerning film patterns should be observed and regularly maintained to avoid progression into severe issues.

When inspection reveals unacceptable commutator conditions, immediate maintenance should be undertaken in order to preserve the commutator's service life. These unacceptable conditions include: bar burning, slot bar burning, pitch bar burning, threading, grooving, and copper drag. All of these conditions lead to severe damage of the materials within the commutator itself. While

minimal damage to commutators is expected over a machine's long service life, regular inspection for these dangerous conditions, profiling commutators to measure roundness, performing touch-up machining, and changing brush grade to eliminate negative impacts will help to detect and repair damage, avoiding catastrophic failures and improving overall motor unit service life. The commutator is the most expensive component of a DC motor unit to replace, so these parts should be the main priority of inspection and maintenance work.

Minimizing grounding, arcing and destructive sparking

After commutator condition, the next most important priority for DC motor upkeep is minimizing grounding, arcing and destructive sparking, by keeping motors clean and clear of the loose carbon dust which is created as brushes wear. Some of this dust goes into the formation of the film on the commutator; however, additional dust may become loose and settle within the motor. This, combined with other particulates from the air, can cause grounding to occur. When this happens and the insulation of the motor fails, motors can experience catastrophic failure. In addition to the danger from undesired grounding, particulates can also make it difficult for motor parts to move freely as they need to. Finally, particulate buildup can inhibit the normal dissipation of heat through the outside surfaces of the motor unit frame and make the motor operate at a higher temperature than is ideal.

To avoid the issues caused by dirty motor units, motor operators should perform annual heavy duty cleans, with occasional light-duty cleans consisting of wiping down the motor unit. The frequency of these cleans can be determined based on inspection observations, since conditions will vary between installations, but performing quarterly light-duty cleans is good practice.

When cleaning, operators should be careful not to worsen conditions by driving particulates deeper into motor units. Proper cleaning consists of vacuuming dry particulates with a soft bristle brush attachment to loosen large accumulations. Oily dirt should be removed with a cloth dampened with solvent. Soaking or flooding a motor unit with solvent can draw conductive particulates deeper into the unit through cracks in insulation, causing more damage. Individual motor parts such as brush holders and springs can be solvent cleaned in this manner outside of the motor safely, but parts like commutators and varnish-insulated coils cannot be.

Carbon films may be removed from commutators to avoid excessive buildup or inspect commutator condition under the film using a medium, soft, white abrasive stone known as a "seater stone," commonly available from suppliers of electrical motor repair parts. Finally, the undercut area between individual commutator bars can be cleaned through a process called air curing. This involves clean, pressurized air being blown onto the commutator as it spins. If dirt is not freed through this process, it may be necessary to mechanically dislodge the particulates and then perform a second round of air curing. Precautions should be taken during any cleaning processes to ensure operator safety.

Black commutations are common in DC motor units. Nondestructive sparking is tolerable and pinpoint sparking that does not cause brush or commutator deterioration is also acceptable. Arcing and destructive sparking, however, can electrically erode both the brush and commutator surfaces. If not corrected, this can eventually lead to equipment failure. Arcing and destructive sparking can be identified by the previously mentioned unsatisfactory commutator conditions in which burning occurs, such as slot bar or pitch bar burning.

Slot bar burning, for example, occurs when sparking levels become high enough to remove metal from the trailing edges of the commutator bars, causing them to appear burned or etched when the brush film is removed. Worsening conditions may cause burning to become evident, even without film removal. Destructive sparking that causes this condition may be caused by the use of a carbon brush grade with insufficient commutating ability, improper electrical adjustment of the motor unit, or exceeding load design limits. Ameliorating the conditions causing arcing and destructive sparking will help to ensure that motor failure and commutator damage is avoided.

Selecting the appropriate brush grade

The third priority when trying to prolong service life is monitoring carbon brush condition. Carbon brushes are the least expensive component of a DC motor unit, though they must be replaced most frequently. Depending on the motor unit and service conditions, carbon brushes are likely to last from three months to three years. Brush life is understandably less important than commutator life and brush grades are chosen with this in mind. Brush grades must be carefully selected to suit the motors' specific application.

Morgan offers the widest range of brush grades currently available in the industry. Each grade contains a different material composition and impregnation designed to optimize service life of the brushes and commutators in a given service condition. While the brushes are primarily made from graphite, some grades include copper or other metals as abrasive or cleaning materials in service conditions where excessive brush film buildup is likely. Similarly, impregnations, or chemical compounds that are introduced into the graphite during production, help to optimize brush film and therefore protect motor unit components. As previously indicated, selecting the appropriate brush grade is important to avoiding commutator damage, arcing, and destructive sparking.

Monitoring environmental conditions such as humidity and temperature as well as consulting with an expert, such as Morgan's sales representatives or application engineers, can help DC motor unit operators to identify the ideal brush grade for each motor installation. This leads to extended brush life and service life for commutators and brush holders.

With proper inspection and maintenance practices, commutator life expectancy ranges from 10 to more than 20 years. These upkeep practices help motor operators to get the best value, performance and reliability from commutators and carbon brushes, and therefore the motor units in general, which results in cost savings and lengthened service life.