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Lifetime and service life of collector brushes

Collector brushes or sliding contacts are used to transmit current from a stationary conductor rail to a moving consumer. The materials used must be suitable for current transmission (good conductivity) and also have the lowest possible wear. Ideally, they therefore also serve to lubricate the conductor rail in order to reduce friction.

A distinction is made between copper graphite and graphite carbons according to the base material. In addition to the base material, which accounts for 80 to 90 percent by volume, additives and lubricants are incorporated. These are used in production, to protect against moisture and to optimize the sliding and wear properties.

Lifetime and Service Life

One of the most frequently asked questions is the service life of a carbon. As with a car tire, this depends on a large number of influencing factors.

Carbon wear consists of mechanical and electrical wear. The main influencing factors are the quality of the contact surfaces, contamination, contact pressure or freedom of movement of the current collectors, due to the connecting cable. But also humidity, voltage form, current as well as acceleration, harmonic waves and maintenance quality influence the operating life.

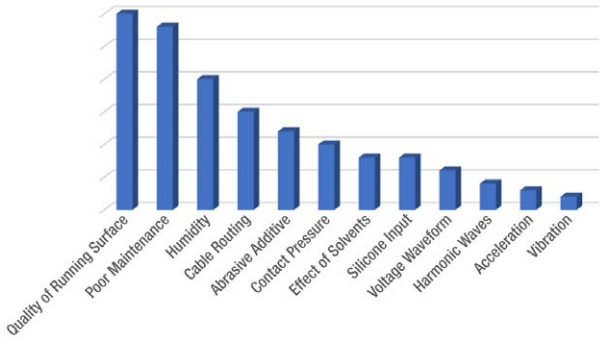
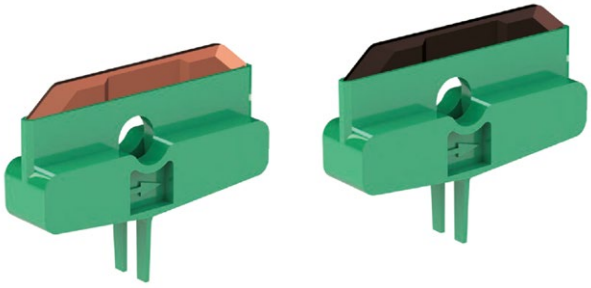


Diagram 1: Factors affecting the service life of collector brushes



Depending on the electrical parameters and the materials composition, the sliding contact and conductor rail are subjected to varying degrees of erosion. In particular, harmonic waves, inductive and capacitive loads, but also current peaks lead to an altered transition behavior and to different material abraison, mostly depending on the polarity.

Even with ideal electrical parameters, erosion occurs which decreases with increasing contact force. The following figure shows this ideal condition. If the electrical parameters change, e.g. due to pulse currents or harmonic waves, the electrical wear also increases with increasing contact force and, over time, also affects the mechanical wear due to rougher surfaces.

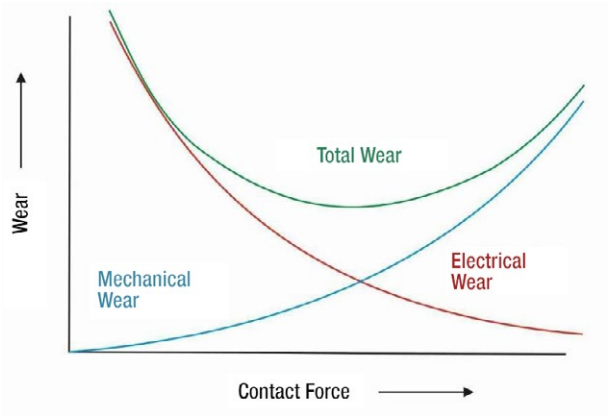


Diagram 2: Wear as a function of contact force

Source: Schunk Carbon Technology // Guide for wear and damage patterns of carbon brushes and grounding contacts

Kinematic Influences / Slanting Use

Unlike collector brushes in slip rings or electric motors, collector brushes are mounted on collector arms in a contactrail system. The aim here is to accommodate the necessary movement tolerances in the x, y and z directions. However, kinematic effects occur with the freedom of movement. Among other things, this can be a reason for a slanted wear of the carbon brush. With increasing dynamics and utilization of the possible freedom of movement, the slanting wear increases. Spring or damping elements are used to minimize this, but they are subject to physical limits. The use of spring or damping elements also depends on the direction of travel of the collector. Different elements are required for reversing operation than for pure towing operation.

Additives and Lubricants

From the beginning of the 19th century until recent years, antimony, beryllium, lead and other substances were used as lubricants and additives. These substances allowed, among other things, a long service life and good resistance to high humidity. Each additive has a different optimum humidity range in which it works best. Therefore, if materials are to be used in the widest possible range of applications, wear behavior is always a compromise and not a constant in every environment.

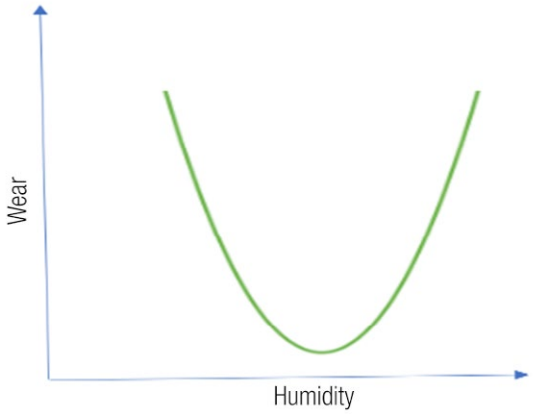


Diagram 3: Wear as a function of humidity

Wear of Copper Graphite and Graphite Carbons

Many years of empirical values and the resulting legal regulations are changing the framework conditions for the use of these additives. A very prominent example of this is lead. The use of this material, which is very beneficial for wear, is increasingly being restricted for health reasons. With a view to the environment and health, substances such as lead are therefore also being successively reduced in materials for carbon brushes and are no longer used in newly developed carbon brushes. REACH- and ROHS-compliant substances are used as an alternative. However, with the disadvantage that a complete

elimination will shorten the service life of the carbon brush or the carbon brush must be optimized in such a way that rail wear does not increase.

Although only used in small quantities (< 2 vol.%), the lubricating effect of lead in copper graphite carbons was significant and can currently hardly be matched by a compliant substitute.

In graphite carbons, wear due to sliding friction has always been significantly lower than in copper carbons, due to the main component, graphite, being the lubricant. As a result, graphite carbons always perform better in terms of sliding wear. However, they are softer and react to rough surfaces, sharp edges or abrasive dusts. As a result, they are more sensitive to disturbances of the sliding surface (rails, overrunning caps and sharp rail joints). In extreme cases, spalling or carbon breakage may also occur.

Graphite carbons are impregnated to prevent the absorption of water from the ambient air. This is physically not completely possible, especially on the sliding surface. In the case of higher humidity or direct water contact, sliding wear increases.

Service Life Data

As a manufacturer, we evaluate wear behavior by means of comparative tests in the laboratory and on test plants. In these tests, material mixtures and alternatives are compared with existing carbon brushes under the same conditions as far as possible. However, as the large number of different influences in customer plants cannot be recorded here, it is not possible to give a binding service life statement. Only the values determined in the laboratory serve as a benchmark for wear behavior, but in some cases they can deviate considerably from the real results in customer plants. In some cases, five years or more pass before the suitability of a new material can be reliably assessed.

Outlook

Due to the omission of the additives previously used, the service life of the carbon brush is expected to change as before, depending on the application and ambient conditions. Feedback on increased wear is not uncommon and must be discussed in detail with the customer.

Since no fully comparable substitutes are yet available from the research side, no one hundred percent solution is likely to emerge in the foreseeable future either. The lubricants and additives used meet the requirements in the laboratory and under controlled environmental conditions, but physically induced restrictions must be accepted in some areas.

Caution when making comparisons

Especially when comparing with carbon brushes from other suppliers or replicas, it must be taken into account that these may not be REACH/ROHS-compliant or that the service life of the carbon brush has been adjusted to the detriment of the conductor rail wear. This partially reverses the principle that the carbon brush is the wearing part. The result is a shorter system life with lower wear part and maintenance costs. In terms of overall costs, therefore, this is a critical approach.

Mileage Details

Due to the complexity of the various influencing factors, information on mileage can only be given as a guide. In practice, depending on the application and environment, the wear during the running-in phase must be checked and the maintenance and replacement intervals determined on the basis of the results. It should be noted that during the running-in phase of new systems, the first one or two sets of carbon brushes still show higher wear. The service life of the carbon brushes increases with the leveling of edges/ joints and the formation of a running track.

In the case of copper rails, a steel-blue to black shimmering patina forms in the running trace. This is essential for the running quality and should not be removed. Polishing“ or brushing with brushes or the use of abrasives or contact spray will damage the system and lead to increased wear.

Further details on maintenance and operation of Conductix-Wampfler conductor rails can be found in the corresponding operating instructions and maintenance instructions for conductor rails or learn more from our Global Product Manager Conductor Rails, Dieter Seidel: dieter.seidel@conductix.com

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