

Technical information

Dr. Ulrich Ringleb

18.08.08

Burn Marks on Commutator Surfaces



For carbon brush manufacturers the carbon brush is **the** indication instrument for the machine status. Vibrations, out-of-roundness etc. can be easily identified by the appearance of the carbon brush.

In this technical information would like to highlight “burn marks on the commutator surface”. With some experience the interpretation of collector pictures may also help to identify possible brush problems.

Mostly blurs or bar marking are described with the term “commutation problems”. That’s right in the majority of cases, but not all of these occurrences can be attributed exclusively to electrical problems, but can also be caused by mechanical problems.

1. „Commutation problems”

Brush sparking alone is not a sufficient evidence for commutation problems. Very often brush sparking can be attributed to other factors like ambient conditions, malfunctions etc. which are not related to the design of the DC motor.

The term commutation has its seeds in the latin word „commutare“, which means as to interchange something, to change or to reverse. In fact the carbon brush on a DC motor works like a switch. It switches the polarity from plus to minus if it changes from bar to bar. If the brush already touches the next bar, although the reversal in the foregoing coil of the rotor winding is not finished yet, we talk about *commutation problems*. The trailing edge of the carbon brush will be overloaded and brush sparking will occur.

Technical information

Dr. Ulrich Ringleb

18.08.08

The main reasons for commutation problems are:

- Brush rocker is not exactly positioned in the neutral zone
- Over- or under-commutation by means of wrongly set interpoles
- Commutation capability of the brush grade in use is not adjusted to the operating or environmental conditions
- Rotor current or motor rotation speed too high

Evidence for commutation problems are:

- heavy brush sparking
- burn marks at the trailing edge of the brush contact surface or also
- blurs or burn marks on the commutator bars

These blurs distinguish themselves significantly from all other kind of blurs, which will be described later: they are sharp-edged, overlap approximately half of the bar and are trapezoidal.



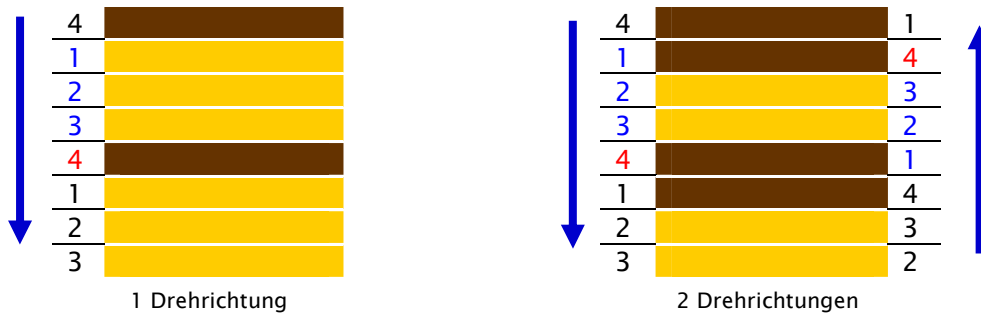
Blurs or burn marks caused by commutation problems are normally to be seen in regular distances at the trailing edge of the commutator bars. Sometimes, depending on the design of the rotor winding, every third, fourth or fifth is affected.

Technical information

Dr. Ulrich Ringleb

18.08.08

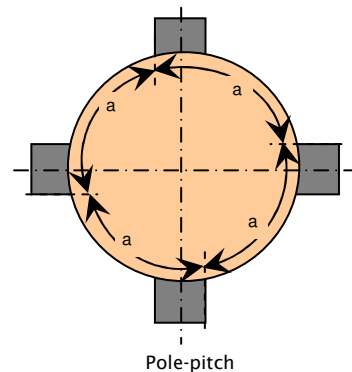
Motors with two turning directions show discolorations according to right sketch below.



Quelle: Interne Mitteilung M. Liebel, Nürnberg

Often “commutator blurs in pole-pitch” can be observed, in an advanced state also “out-of-roundness in pole-pitch”. Pole pitch is the distance between the brush arms.

Here one bar is more burned than the adjacent one – accidentally or by means of electrical or mechanical abnormalities (e.g. by resistance differences due to unbalances in the winding, commutator deformations etc.). The current transfer at this bar is disturbed, the electrically parallel brushes of the same polarity have to transfer more current and are thereby overloaded.



Advanced burn marks in pole-pitch also appear in an out-of-roundness measurement.

Remedial actions in case of commutation problems are:

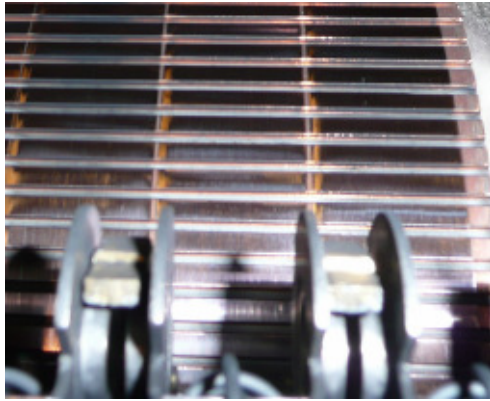
- Check and if applicable adjustment of the neutral zone
- Check and if applicable adjustment of the interpole (interpole air gap)
- Check of the control device
- Check of the brush grade and
- Check of the brush design

Technical information

Dr. Ulrich Ringleb

18.08.08

2. Vibrations



Detailed information about vibrations, their causes and remedial actions is given in a separate technical information, also available on the SCHUNK website.

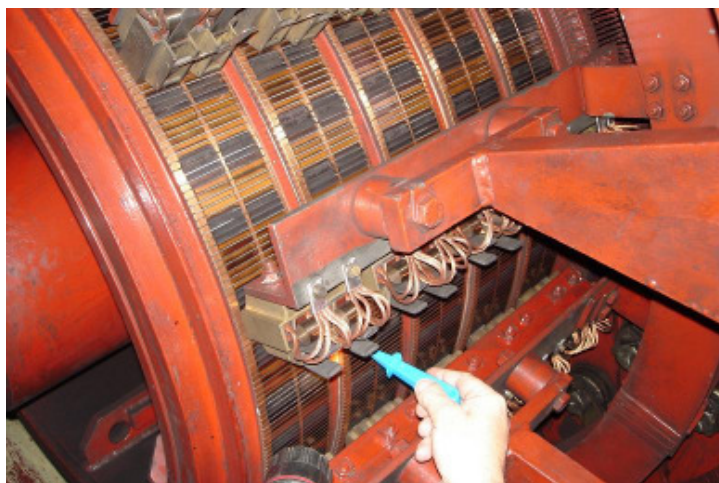
Brush sparking caused by vibrations triggers a slightly different commutator pattern. The blurs and burn marks are not sharp-edged but rather washy. The whole bar can be affected and particularly the burn marks are not regularly distributed on the commutator perimeter. (see also picture T12, T14 in the illustrations of commutator states of the well known carbon brush suppliers).

3. More electrical problems

Electrical failures like

- Broken commutator leads or stabilizing windings
- Short circuit in the armature winding
- Broken armature winding

do also cause characteristic damage symptoms.



Broken commutator lead

Technical information

Dr. Ulrich Ringleb

18.08.08

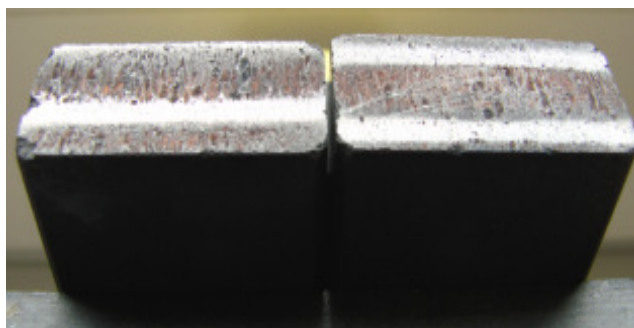
Loosen or high resistance connections between the armature winding and the commutator bars cause burn marks, starting at the bar directly adjacent to the segment with the broken lead. The contact between brush and commutator gets worse and the whole commutator shows more and more sign of burning. In an advanced state flat spots and burn marks will show up, regularly distributed around the commutator perimeter.

Single bars with poor film formation due to reduced current flow are an indicator for broken commutator leads.



A by-product of bad commutation conditions is a special marking on the brush contact surface. The contact surface is divided in zones, each one bar width wide.

That phenomenon is caused by abnormally high current density in parts of the contact surface during dedicated phases of the commutating process.



Technical information

Dr. Ulrich Ringleb

18.08.08

4. Standstill load

During standstill phases DC motors may be loaded only for a limited time to avoid damage of the commutator. At interval operation DC motor OEMs recommend a duration of max. 20 seconds at 100% overload.

It has to be considered, that standstill load in the same position of the rotor e.g. in case of restarts of blocked extruders etc. , may be repeated only, if commutator and armature are sufficiently cooled down.



Due to the locally high temperatures in case of impermissible standstill load the copper of the commutator bar will be softened and changes its structure permanently. Thus flat spots and out-of-roundness will show up during operation.

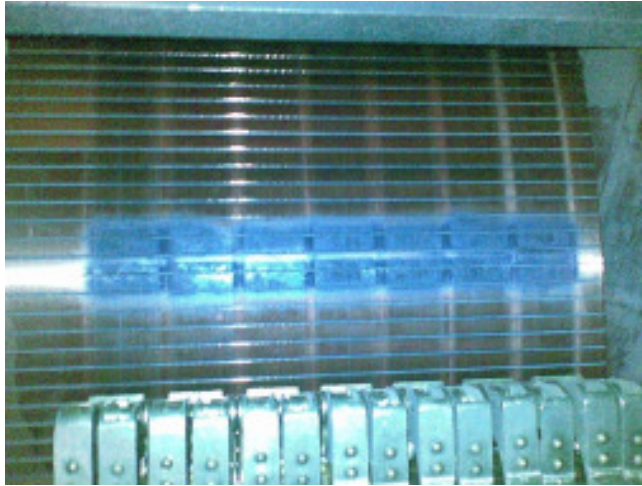
The commutator bars will expand. Due to the arch pressure inside the commutator they will not move back to their original position while cooling down. That also causes out-of-roundness, brush vibration and further after-effects.

A special form of blur formation shows up on commutator surfaces during shutdown, if the combination carbon brush / commutator forms a galvanic element due to high humidity. To avoid the formation of those blurs it is strongly recommended to lift the brushes or to put an insulating pad underneath the brush contact surface during long downtime or for example in case of sea transport of new motors.

Technical information

Dr. Ulrich Ringleb

18.08.08



Compact

- Electrical and mechanical faults cause characteristic burn marks on commutator surfaces
- Electrical and mechanicals faults cause different commutator patterns
- Damage symptoms inform about possible problems

Heuchelheim, August 2008