Technical Information

Brush dust

The combination carbon brush / counter material is a so called wear partnership – the brush is the wearable part, the counter material shouldn't be damaged.
The wear rate of carbon brushes depends very much on the operating conditions such as peripheral speed, environmental conditions, load conditions etc.
The following data are guide line values:

- Stationary machines 2 – 7 mm/1000h (0,08 – 0,27 in/1000h)
- Traction machines 2 – 4 mm/10000km (0,12 – 0,26 in/10000miles)

Depending on the brush grade in use the brush dust is more or less sticky and conductive. If not removed by means of adequate vents, filters or even vacuum cleaners it may have a negative influence on operation reliability.

- Even thin layers of brush dust attached to the windings may reduce the insulation resistance remarkably
- Brush dust adhered to the winding hinders the convection of the heat
- Polluted insulators are very often the cause of flash over
- Brush dust with oil or humidity may cause stuck brushes

Mechanism of wear

There are various models for the explanation of wear phenomena between friction partners. Unlike common friction partnerships an electrical wear has to be added to the purely mechanical wear i carbon brushes are considered.

By means of the friction of the carbon brush on a commutator or slip ring a mechanical stress is triggered in the contact surface. Thus the structure of carbon particles coming from the raw material and the "carbon bridges" of the binder are broken. The grains of the raw mate-

rial get virtually flexible.
Therefore the brush wear is usually formed by particles of two different grain sizes of the raw material and the binder.

Electrical current may cause local overheating and brush sparking in the contact surface. At low temperature this gives rise to combustion and at higher temperatures to sublimation of the carbon. This can recondensate and create an extremely fine carbon dust.

Grain size

Actually granular analysis of brush dust has shown, that brush dust of electrograohite, carbon-graphite and graphite brush grades is mainly composed of two grain sizes. The grain size distribution depends of course on the grade in use,.

The grain size distribution is influenced by the operating conditions

- At high peripheral speed and low electrical load the mechanical factor is dominating and larger particles are formed.
- At lower peripheral speed and high electrical load the electrical factor will dominate and smaller particles are formed.

The following graph shows the percentage of different grain sizes in brush wear dust of an electro graphite grade and of a metal brush grade created during a lab test on a damaged collector.

The operation conditions were:

- 12 A/cm² (77 A/in²) current density
- 30 m/s (100 ft/s) peripheral speed
- 90° C (194 °F) collector temperature

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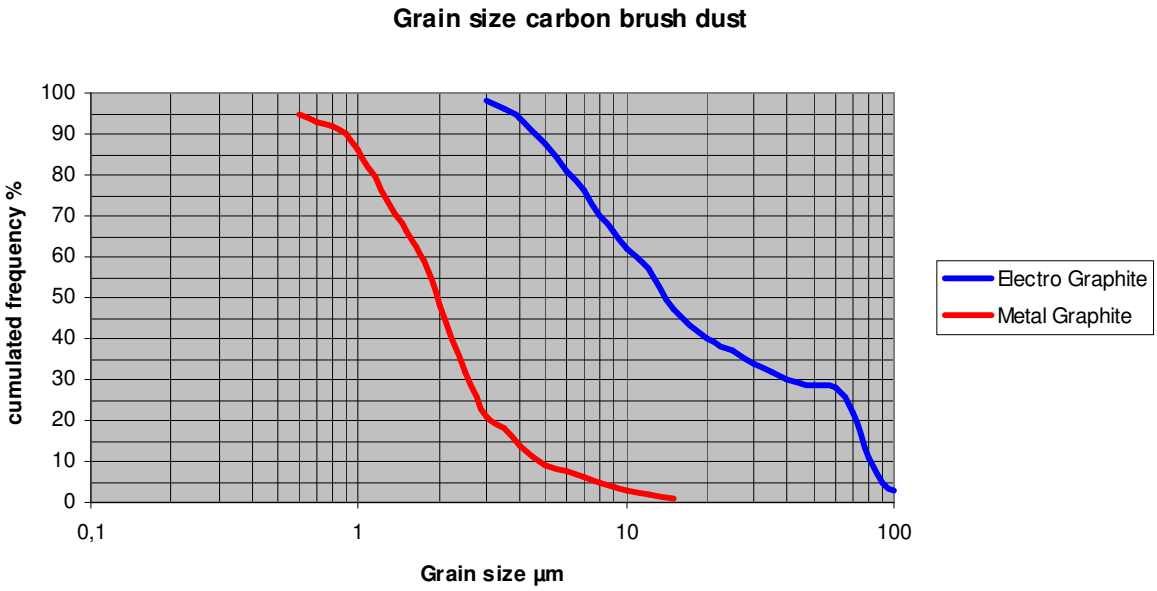

With these conditions the brush dust has the following composition:

- Electro graphite
  Ultra fine dust 5 – 22 µm
  Fine dust 60 – 90 µm
- Metal graphite 1 – 4 µm

The diagram can be understood as following: 80% of the “electro graphite dust” is smaller than 6 µm. 80% of the “metal graphite dust “ is smaller than 1.5µm.
These data are important for the selection of suitable filter materials.
Dust of graphitic brush grades is quite often greasy and sticky, whereas brush dust of highly metal containing brush grades is rather dry and less sticky.

Electrical conductivity

The direct measurement of electrical conductivity of any dust is not possible without a high measurement inaccuracy.

As already mentioned brush dust of metal brush grades is very fine. Moreover it has got a larger specific surface area, is more reactive and very fast oxidising.

In air copper dust oxidises very easily to copper oxides. Solid copper oxide has got semi-conductor like properties and an electrical conductivity in an order of magnitude of 10^{-2} S/m. Parallel to the carbon layers graphite has got a conductivity in the range of 10^{6} S/m,. So graphite is much more conductive than copper oxides.

Unlike the general belief brush dust of metal brush grades is less critical concerning a drop of the insulation resistance than brush dust of graphitic grades.

Compact
• Extraordinary amount of brush dust disturbs the operation of motors • Electro graphitic dust is more coarse than metal containing brush dust • Graphitic dust is more conductive than metal containing brush dust