DUST ARISING FROM BRUSH WEAR

TECHNICAL NOTE ■ STA BE 16-48 GB

CAUSES AND EFFECTS

A brush wears inevitably when it rubs against a commutator or a ring, and y wearing dust is produced.

If care is not taken, such dust can be very detrimental to the functioning of a machine, because:

– It is adherent, acts as a conductor and is ionisable.

A layer of such dust even when very thin, on the winding of a machine, can dangerously lower the insulation resistance.

In mass between the winding, there is an occasional danger of it becoming energized, an accident which is always devastating but has an even greater risk when:

- the voltage is very high,
- the dust is very metallic,
- the machine is totally enclosed,
- visits for maintenance and cleaning are spaced at long intervals.

– The dust is fine, light and thermally insulating.

A layer of dust, though very thin, on the winding of a machine, partially screens the hot masses from the action of ventilating air currents, and the dispersion of losses by convection are noticeably diminished.

It can also be introduced, into the ventilating air-duts and also between brush and brush-holder with resultant stiction or wedging of the brush, this is a frequent cause of sparking at the brushes.

MECHANISM OF WEAR

Wear of a brush is caused by a double action, mechanical and electrical.

As a result of friction the carbon layer in contact with the commutator (or the ring) gives rise to important constraints. The structure, formed by elementary grains attached one to the other by carbon "bridges" tend to unlock themselves by the breaking of these bridges, which, in turn, brings freedom to the grains — this is wear of mechanical origin — and "friction dust" will usually be formed into two different average sizes: that of the bridge debris and that of the grains.

The passage of current in the interface cannot be brought about without micro-sparking and heating nor, consequently, without a loss of carbon material through sublimation (at high temperature) and through combustion in air (at low temperature): this is wear of electrical origin.

In every instance, the dust produced through electrical wear is of very small particle size, as it is an integral part of the carbon of recondensation and of refractory burning that the particles formed are always extremely fine.

It may be added that the average size of the dust of electrical origin depends on the polarity of the brush which brings it about. The finest dust originates from the anode brush and the least fine from the cathode brush (in accordance with observations made on the wear dust of electrical arc carbons).

METRIC GRANULAR STUDY

As a matter of fact, the granular analysis of wear dust from amorphous, electrographitic or graphite brushes shows two distinct types of grains. The proportions of these two constituants vary from one grade of brush to another, but the two individual types, and only two, are always present, as can be seen from the curve *Fig. 1*.

At the same time, the relative proportions naturally depend on the working conditions of the brush. The quicker the commutator rotates and the weaker the current in the brush, the greater the wear caused by friction and the greater the relative size of the wear dust.

The opposite applies to brushes which are heavily loaded on slow commutators. The electrical wear is dominant and the relative particle size of the dust diminishes.

Accordingly, curves (*Figs. 1* and *2*) above show the wear dust for two brushes, one electrographite and the other metal graphite, which were both used on a faulty copper commutator in the following circumstances:

- Peripheral speed : 20 m/s
- Current Density : 13.5 A/cm^2
- Commutator temperature : 60-65°C

These curves show:

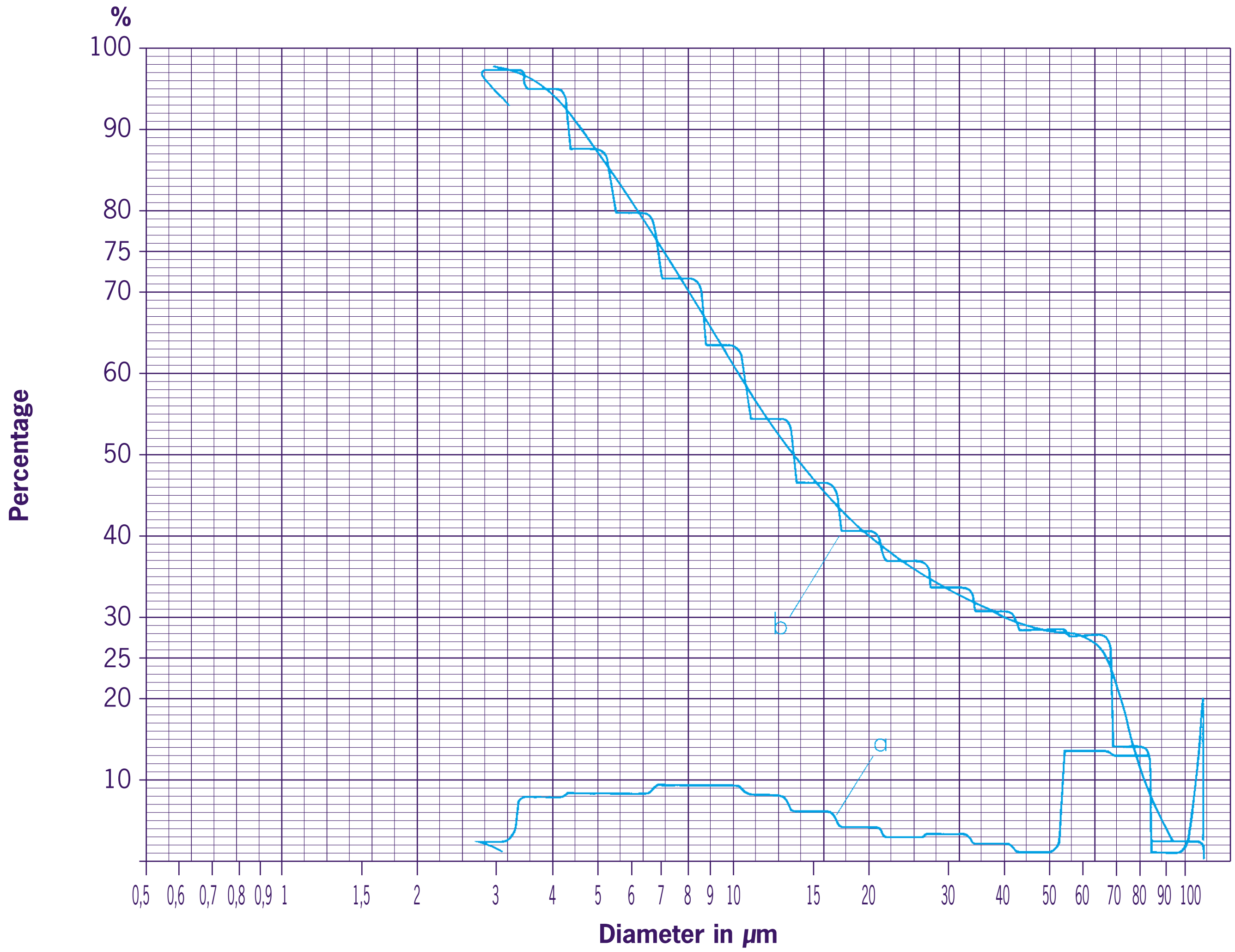

Fig. 1

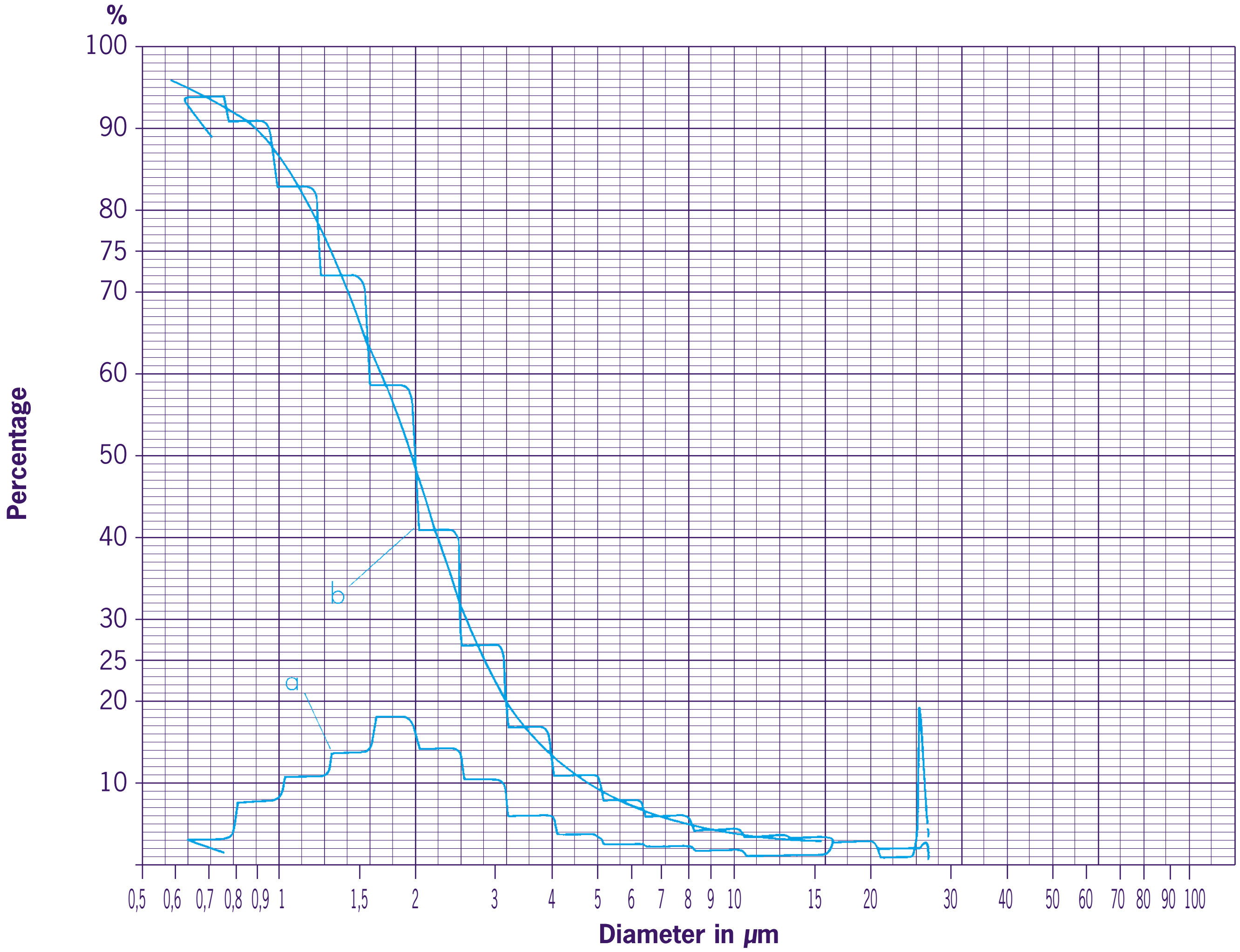

Fig. 2

- The ordinate (linear). The relative composition in granular metric steps (a) and the relative cumulative composition of the dust (b).
- In abscissae (logarithmic) the corresponding size in microns of the dust grains.

Thus, in these precise highly loaded operating conditions, the approximate sizes of the wear dust of electrographite brushes (curve 1) are:

- for the ultra fine dust : 4 to 20 microns,
- for the fine dust : 60 to 80 microns,

and in order to stop 80% of the dust, it is necessary to fix filters efficient to 6 or 7 microns in the ventilation circuit of the machine.

For wear dust from metallic brushes produced under the same working conditions, the curve 2 shows the grains are for more than 80%, of a size superior to 1 micron and in order to neutralise these dusts, it is necessary to use the filters which are efficacious to 1 micron.

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