TECHNICAL DATA SHEET

LOSSES IN BRUSHES

Brush losses on slip rings or commutators are not always correctly calculated. They represent less than 10% of the total losses of a modern DC machine used within the normal limits of load.

These losses come from 2 different sources:

01 - LOSSES OF MECHANICAL ORIGIN P_f

Mechanical losses are due to the **friction** between the brushes and commutator or slip ring.
They are calculated in watts by the following formula:

$$P_f = 10 \times \mu \times F_r \times v$$

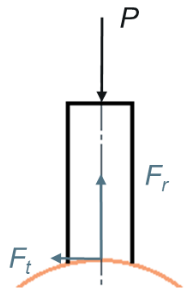

Figure 1 - Forces acting on the brush (radial position)

where:

μ is the **friction coefficient** of the brush on the commutator or slip ring.
It is defined as the ratio between the tangential force F_t and the reaction force F_r acting on the brush: $\mu = \frac{F_t}{F_r}$.
Its value depends on the spring pressure, the grade and the peripheral speed*

F_r is the **normal component of the force** applied on the brush on the commutator or slip ring, in daN.
Its value is equal to the pressure applied on the brush (for more information consult TDS/11),

v is the **peripheral speed** of the commutator or slip ring, in m/s

REMARKS

- The pressure p to be applied on the brush* is given by the formula:

$$p = \frac{F_r}{S}$$

where:

S is the cross section of the brush, equal to t x a (for a radial brush as per figure 1), in cm²

p is expressed in daN/cm² when F_r is in daN (see also TDS-11)

Therefore the formula for mechanical losses becomes:

$$P_f = 10 \times \mu \times p \times t \times a \times v$$

- For a brush with a contact bevel angle α (see TDS-04), p is given by the formula:

$$p = \frac{F_r}{S \times \cos\alpha}$$

Therefore the formula for mechanical losses is:

$$P_f = 10 \times \mu \times p \times (t \times a \times \cos\alpha) \times v$$

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02 - LOSSES OF ELECTRICAL ORIGIN P_e

Electrical losses are mainly due to the **Joule effect**, due to the flow of current through the brush.
They are calculated in watts by the following formula:

$$P_e = I \times \Delta U$$

where:

I is the **current intensity**, in ampere

ΔU is the **brush voltage drop***, in volt, for the considered current *I*.

Remarks:
- For low resistivity grades *ΔU* is considered to be equal to the contact voltage drop.
- The temperature of commutator or slip ring plays a significant role on the contact voltage drop: *ΔU* decreases when temperature increases.

*** Notes:**

- Recommended pressure and resistivity for each grade, as well as a classification of friction coefficient and voltage drop are indicated in Mersen's Carbon Brush Technical Guide.
- Indicative values of friction coefficient (as a function of peripheral speed) and brush voltage drop (as a function of current density) are specified in Mersen grades Data Sheets, available upon request. Measurements are performed in our Laboratory according to the standard IEC 60773.

List of references:
Mersen's "Carbon Brush Technical Guide"
TDS-04: Dimensions of carbon brushes
TDS-11: Pressure on carbon brushes
IEC 60773: Test methods and apparatus for the measurement of the operational characteristics of brushes
Mersen's "Carbon brushes for motors and generators" technical guide

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