

1. The optimal Brush Pressure

The basic principle: Pressure should be sufficient to ensure a true and continuous contact on the slip ring or commutator at all working conditions of the machine.

The optimal brush pressure results from both electrical and mechanical considerations.

1.1. Electrical

Every interruption of the contact collector / carbon brush is the cause for brush sparking , burn marks increased brush wear etc.

Therefore the brush pressure should be increased on machines,

- subject to shocks and vibrations (such as traction motors, press drives, drives for container cranes, propeller drives, fan drives etc.), or
- motors with bad stability (unbalance, out-of-round)

An increased brush pressure has an effect only in case of external factors. An increase of brush pressure against brush vibrations caused by too smooth collector surface is useless. In the contrary: the mechanical losses will be increased, the friction coefficient will be raised, and brushes as well as brush holders might be severely damaged.

The contact drop of the carbon brushes is decreased when the brush pressure is increased. Consequently the commutating properties if the brush decreases at high pressure. This effect should not be considered as insignificant. For a standard electrographite grade it can reach 30% if pressure goes from 200 cN/cm² to 500 cN/cm²

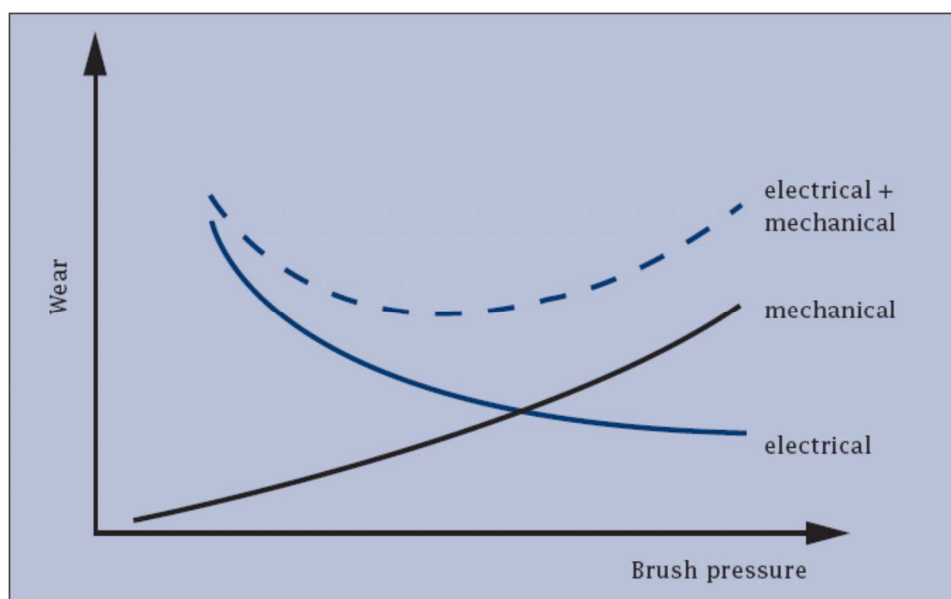
At high current loading the wear rate of the brush can be decreased significantly by increasing the brush pressure. Due to the elasticity of the carbon brush grades the number of contact points is enlarged with an increased brush pressure. Therefore the current is distributed on a bigger area.

1.2. Mechanical

The mechanical losses and the brush wear are increasing with increasing the brush pressure.

The maximum tolerable pressure for a brush depends on the mechanical strength of the material. All soft or fragile grades are not suitable for applications requiring a specific pressure higher than 300cN/cm^2 . The maximum suitable brush pressure for natural graphite grades used on turbo-generators is limited to 160cN/cm^2 only.

The following diagram shows the principal graph of the brush wear as a function off brush pressure.



1.3. Summary

Too low brush pressure may cause:

- brush sparking,
- increased wear of collector or slip ring,
- increased brush wear,
- increased collector temperature.

Too high brush pressure may cause:

- increased mechanical losses, but less electrical losses
- increased temperature, particularly critical for steel slip rings and electrographite grades,
- increased brush wear and collector wear.

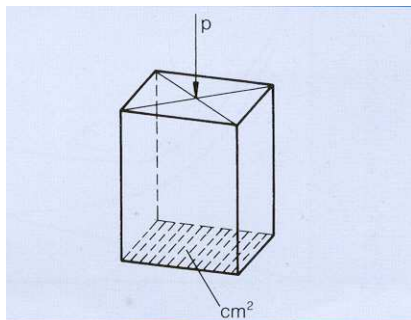
To sum up:

The brush pressure should be as low as possible, without separation of the contact brush / collector.

Uneven brush pressure may cause specially with a lot of brushes in parallel:

- uneven current distribution and overloading of individual brushes,
- uneven brush wear,
- trackwise grooving,
- damage of pig tails, finally burned pig tails due to overheating.

2. The Specific Brush Pressure



The physical unit for pressure is Pascal (Pa), where 1 Pascal 1 is Newton per m² (N/m²). Pressure is a force per area. Therefore brush pressures are given in centiNewton per cm² (cN/cm²). 1cN/cm² = 1 hPa
1cN/cm² is equal to 1 g/cm².
Because this value is related to an area it is also called specific brush pressure,.

The specific brush pressure can be calculated quite easily from the measured pressure and the brush dimensions.

$p = \frac{P}{t \times a}$	Brush dimensions 25 x 32 x 50 mm ³ Measured force 2,5N or 2500cN
t : tangential dimension in cm a : Axial dimension in cm P : Measured force in N (kg)	$\frac{2,500cN}{2,5cm \times 3,2cm} =$ $= 312,5 \text{ cN/cm}^2$

The surface considered as the basis of calculation for the pressure does not take into account the empty space under the brush - space between the bars of the commutator, grooves of helically grooved slip rings, oblique saw cuts in the contact faces of the brushes – but only the cross section of the brush. For brushes with a bevelled face the pressures are calculated from the cross section and the real surface of the contact faces is not used for the calculation.

3. Guide Line Values

Some guide line values for the specific brush pressure are summarised in the following table. The data are given in as cN/cm² (hPa)

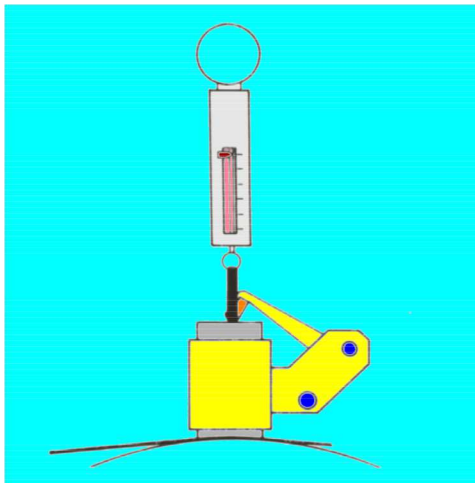
Type of machine	Stationery DC drives	Traction motors	Truck motors	Slip rings
Natural graphite - F	-	-	-	130 – 160
Resin bonded Graphite - F	180 – 250	-	-	-
Electrographite - E	180 – 300	250 – 550	250 – 450	130 – 220
Metal graphite A,B,C,K	180 – 300	-	-	200 - 300
Carbon graphite – L	200 – 450	-	250 – 450	-
Silver graphite - S	180 – 300	-	-	200 - 300

The permissible tolerances for the specific brush pressure depend strongly on the pressure system in use. A band width of $\pm 10\%$ can be considered as normal.

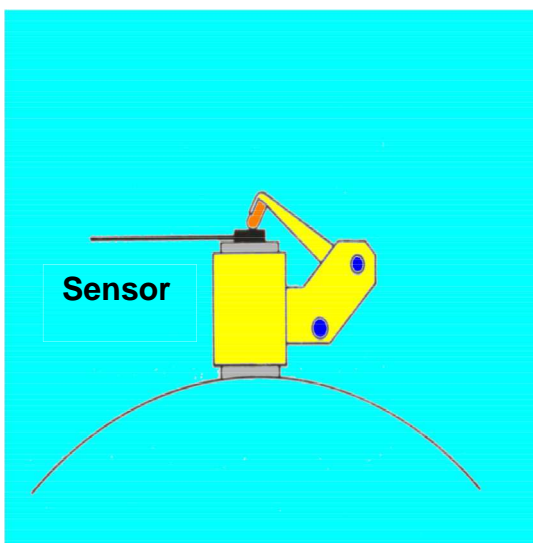
The value of the brush pressure might change with the remaining length of the brush. This depends on the characteristic of spring type in use.

4. Measurement of Brush Pressure

The measurement of the brush pressure is a measurement of forces in its truest sense. Several types of electronic devices are meanwhile available.



The most simple device for the measurement is still the spring balance. Measurement with constant force spring systems is not possible. A hook is fixed at the pressure finger for the measurement. And the spring balance is pulled perpendicular to the brush holder. The pressure is working in radial direction of the brush. A measurement in a diagonal direction would be falsified by other forces. The point where the pressure finger is lifted from the brush top is the force to be measured. This value is divided by the surface area and results in the specific brush pressure.



Electronic devices can be used to measure the force of the pressure spring directly at its contact point on the brush top. One of our competitors offers such an instrument, which has in our opinion an unsuitable sensor. According to our experience the measurements are difficult to be reproduced.

Much more suitable is an instrument of a French company. A piezo-sensor is fixed underneath the spring.

We did extensive tests with this instrument in our brush holder production SBI, Wettenberg. This instrument guarantees accurate and reproducible data.



Characteristics of this instrument:

- Alternatively force or pressure on the display
- Alternative units (PSI, Pascal ...)
- Print of the data on a separate printer
- Recording and analysis with Windows-Software on separate computer
- Measuring range 50 to 6000 cN
- Resolution 5cN
- Data memory for 30 measurements
- Sensors for max. 1N, 2N und 6N

Spring balances with measuring ranges of 1kg, 2.5kg and 5 kg and the digital instrument are available directly from SCHUNK Kohlenstofftechnik

Fax: +49 641 608 1748

Email: infobox@schunk-group.com

Facts in one view

- ↪ The optimal pressure is a compromise of electrical and mechanical aspects
- ↪ The pressure is a function of application and grade in use
- ↪ Differences of $\pm 10\%$ can be tolerated
- ↪ Easy measurement with a spring balance
- ↪ Reproducible, registerable data with the instrument recommended by SCHUNK



Brush Pressure

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