CONDITION OF THE SURFACE OF COMMUTATORS AND RINGS-ROUGHNESS

TECHNICAL NOTE ■ STA BE 16-1 GB

It is often erroneously thought that after rectification of a commutator (or a ring), the surface should be brilliant and as brightly polished as possible.

On brilliantly polished commutators, friction is higher, particularly at start, and is stabilised more slowly than on initially unpolished commutators, as is shown in diagram 1.

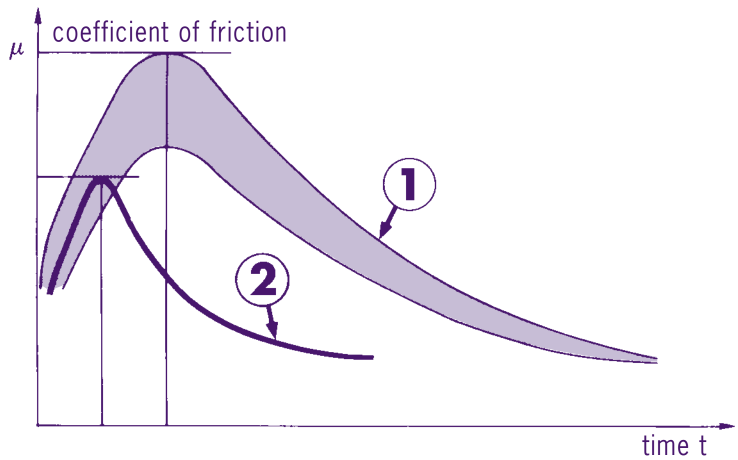

Diagram 1

1 - Commutator polished and bright R_a: 0.2 μ *2 - Commutator unpolished R_a: 1.5 μ*

This difference in performance is due to two causes which to a certain extent are linked:

– When the contact between the friction surfaces tends to approach perfection the friction forces become much greater, then vibrations and considerable heating are produced.

– On commutators which are polished and bright, the graphite, one of the essential constituents of the skin, is poorly abraded from the brush or, it is leaves on the metal and fails to firmly adhere.

These disadvantages do not appear on unpolished commutators which are slightly rough: the skin forms normally and the brushes rapidly establish a stable condition.

On the other hand, if the final surface is too rough, the commutator works rather like a grinding wheel and as a result excessive wear of the brushes occurs.

From this, it will be seen that the roughness of commutators and rings must be confined to certain limits, and it is for this reason that you should not hesitate to remove the polish from a commutator, if it is too smooth and bright (grinding stones, fine abrasives,...).

The roughness of the surface can be measured without difficulty. Such measurements, however, are expressed in several different ways, and the various terms should not be confused as each method has its own corresponding evaluation. It is, therefore, important to keep in mind the definitions given hereafter.

DEFINITION OF ROUGHNESS

Several definitions of roughness exist; the French standards NF E 05015 and E 05017 as well as the German standards DIN 4762, DIN 4768 and DIN IEC 773 particularly treats this question in detail.

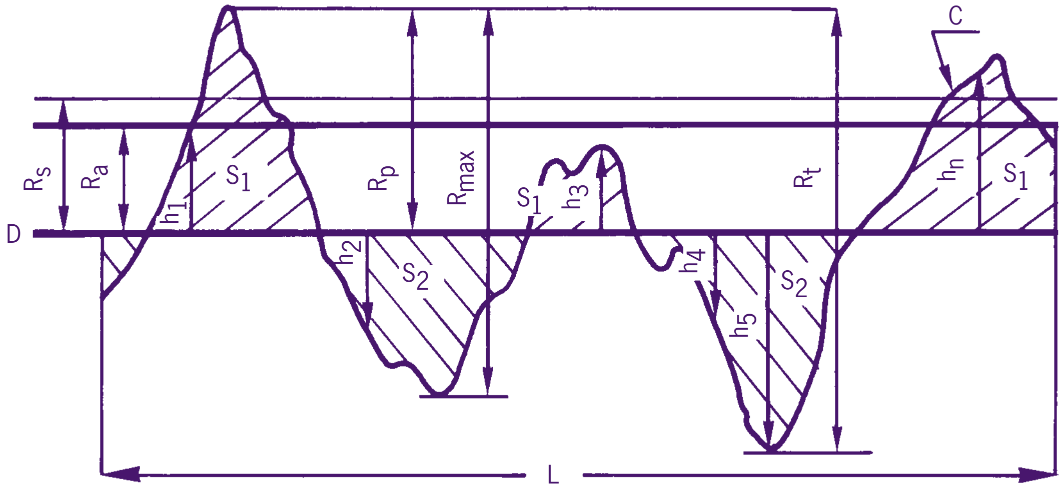

Diagram. 2

In diagram 2:
- The curve C represents the profile of a section of a rough, surface on a length L.
- The line D is such that the sum of the surface S_1, situated between C and D above D should be equal to the sum of the surface S_2 situated below D.

R_t: total depth or total roughness variation is the distance between the highest crest and the deepest trough.
R_{max}: depth or maximum amplitude of roughness, is the maximum distance between a crest and the consecutive trough,
R_s: Average geometrical variation is the effectual value of the variation of h between C and D.

$$R_s = \sqrt{\frac{1}{L}\int_0^L h^2\, dL} = \frac{\sqrt{h_1^2 + h_2^2 + \dots + h_n^2}}{n}$$

This value R_s is used in the United States of America and is designated by RMS (Root Mean Square). It corresponds also to the following designations: R_g, R_q, H_{rms}, RMC, RMQ.
- R_p: depth of imperfection is the distance between D and the highest point of the profile.
- R_a: Average arithmetical variation between C and D is the average height h of the different heights h_1, h_2, h_n, always taken with the plus sign.

$$R_s = \frac{1}{L}\int_0^L |h|\, dL = \frac{|h_1| + |h_2| + \dots + |h_n|}{n}$$

Other designations AA: (Arithmetical Average) in the United States.
Ru and CLA: (Center Line Average) in Great Britain.
Measuring apparatus gives simultaneously R_a, R_s, R_{max} and R_p but R_a is the one most commonly used, and which we have retained for the measurement of roughness of rings and commutators.
The degree of roughness is expressed in microns (µ) but certain countries use the micro-inch (1 µm = 40 micro-inches).

VALUES WHICH ARE RECOMMENDED FOR THE DEGREE OF ROUGHNESS R_A OF RINGS AND COMMUTATORS

Roughness below or equal to 0.2 µm should be avoided. It is necessary to remove the polish from the surfaces.
Roughness overpassing 2 µm, brings with it excessive wear of the brushes.
From our experience, we would recommend:
0.9 to 1.8 µm for the commutators of industrial machines.
0.5 to 1 µm for small commutators of machines with a capacity lower than 1 kW.
0.75 to 1.25 µm for steel or bronze rings.

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