Selected aspects of the electrical behavior in sliding electrical contacts

C. Holzapfel
Schleifring und Apparatebau GmbH
Am Hardtanger 10
D-82256 Fürstenfeldbruck, Germany
cholzapfel@schleifring.de

***Abstract*—In this study, a simple model system is used for describing selected aspects of the electrical behavior in sliding electrical contacts. The resistance of a slip ring consists of static components (e.g. brushes), systematically varying components (effective track resistance) as well as non-periodic components (contact noise). Depending on the speed and wear state of the system the electrical behavior will be fundamentally different.**

Electrical sliding contact; electrical noise; tribological system, contact resistance, wear

I. INTRODUCTION

Sliding electrical contacts in form of slip rings are used to transfer electrical power or signals from a stationary to a rotary machine part. Examples are medical applications such as computer tomography as well as industrial applications such as wind power. Any slip ring forms a tribological system with an additional flow of an electrical current. The contact resistance of this system is continuously changing due to a number of different reasons. Especially important are the wear state of the system and the dynamic behavior (e.g. vibrations).

Previous studies on the behavior of sliding electrical contacts are numerous and only some examples can be mentioned here [1, 2, 3, 4, 5, 6, 7]. In the previous Holm conference [7] showed the evolution of wear as a function of life time. In this study the wear state of the system was also linked with its electrical behavior as well as the dynamic state (occurrence of vibrations). In principle it was shown that the low frequency noise (0-4 kHz) is a direct measure of the state of the system.

The electrical noise in a sliding electrical contact is measured as the change in contact resistance as a function of time within a certain frequency range. Any practical measurement is composed of different components: constant contributions from the elements of the current path (e.g. brushes), varying components from the design itself (effective length of track), varying components from the contact itself (e.g. distribution of contact points) as well as varying components of electrical noise from the surrounding. Any measurement of the noise has to be interpreted taking these different components into account. For some aspects as shown later it will be necessary to interpret the data in the frequency range (e.g. for the detection of vibrations). Auto-correlation analysis will be used to analyze the noise with respect to the position of the track.

This study describes first the development of a regular change in the resistance resulting from the specific track geometry. Second this regular variation is discussed using data from [7]. Third the principles of autocorrelation analysis are briefly described. In the remaining part of the paper, the time and frequency dependence of the contact resistance is thoroughly discussed using a life time test with a very simple model system. This model system is not designed for optimum performance but is used for deducing a basic understanding of the underlying principles in sliding electrical contacts.

It should be noted that within the scope of the present study the term contact resistance is used for the resistance of the total current path between the two probes for the measurement of the voltage drop. Hence it somewhat differs from the physical definition of contact resistance (equal to the constriction resistance plus film resistance of any intermediate layer [8,9]) and can be interpreted as a practical value useful for characterizing the total slip ring system. In other studies contact resistance is also used in this way because the direct measurement of the physical value defined above is experimentally challenging (at least for a slip ring design).

II. EXPERIMENTAL TECHNIQUES

This paper describes selected aspects of the electrical behavior in sliding electrical contacts by first using experimental results from [7]. In addition these results are further used in discussing a life time test which, in principle, is identical to the setup already described in the earlier study. Only the contact system itself was changed: The present study uses another galvanic coating system that has a similar wear characteristic like Rh with hardness higher than the contact wire (coating system 1). All electrical measurements were performed identically as described in [7] and are only briefly discussed below. The measurement setup is shown in more detail in Figure 1 in [7].

Electrical characterization was performed by using a Yokogawa DL 750 digital recorder. This instrument can be used at a bandwidth between 400 Hz and 400 kHz. However, all electrical measurements reported in this study were conducted using a bandwidth of 4 kHz. This choice of bandwidth is a compromise between collecting a sufficiently

978-1-61284-648-4/11/$26.00 ©2011 IEEE