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COMMUTATOR AND COLLECTOR RING PERFORMANCE

Commutator and Collector Ring Performance

Commutator and collector ring problems on exciters of hydrogenerators, which have been most prevalent in Reclamation experience, are often misunderstood. This discussion, although by no means a full treatment of this complex and lengthy subject, gives some basic elements of an adequate maintenance program. The literature listed in the bibliography, only a segment of that which has been published, should be available to maintenance personnel on each project. Troubles which cannot be readily corrected should be referred to D-8440 or D-8450.

Good Performance of both commutators and collector rings is mainly dependent upon the formation of the correct thickness of surface film which is tough, glossy, and has low friction. Moisture absorbed from the surrounding air is an important component of the film. If the ambient air is abnormally dry the film dries, causes friction, and the rate-of-wear increases.

Heat increases the formation of oxides, which are also essential to a good low friction film. The most prevalent problem with exciters has resulted from insufficient heat because of insufficient load which has not allowed adequate film formation. Because the exciters are generously rated, the average load is only about half the nameplate rating. The manufacturer customarily equips the exciter with a good grade of electrographic brush according to the nameplate rating. These brushes may have good characteristics and perform excellently at nameplate rating or medium to heavy load, but perform poorly on light load.

1. - COMMUTATOR

Recognizing these conditions characteristic of Reclamation operation, it is not surprising that better performance can usually be obtained by removing half the brushes from the commutator surface. This increases the current density and temperature which aids film formation. Most electrographic brushes are recommended for current densities of 0.093 to 0.109 A/mm^2 (60 to 70 A/in^2), but will usually form film satisfactorily for densities down to 0.062 A/mm^2 (40 A/in^2). Although this is an approximate guide, the brush manufacturer's specific recommendations should be used.

DO NOT INTERFERE WITH PROPER BRUSH STAGGER WHILE OPERATING A COMMUTATOR WITH SOME OF THE BRUSHES LIFTED. AN EQUAL NUMBER OF POSITIVE AND NEGATIVE BRUSHES MUST COVER EXACTLY THE SAME PATH ON THE COMMUTATOR.

It is usually easiest to avoid disturbing this stagger pattern by removing brushes toward one end of the commutator, and concentrating current on the other portion. Wear can be distributed by periodically alternating portions of the commutator being used.

2. - COLLECTOR RINGS

Unlike commutator performance, collector ring performance can seldom be improved by removing brushes. The most common trouble is excess film formation on one ring. Film Is formed principally under the positive brush. The negative ring frequently shows the most wear, which is variously explained as lack of film or as transfer of metal in the direction of current flow.

Less film is required on rings, but excess film results eventually in punctured film, uneven distribution on current, sparking, roughness and rapid brush wear. While commutator brush film is easily controlled by equalizing the brushes; nearly as much benefit can be obtained on a collector by frequently changing polarity. If the ring polarities can be changed as often as from 1 to 3 months the film can usually be maintained on both rings.

Longer intervals may serve only to distribute the roughness which develops. This type of frequent maintenance is sometimes impractical, and other types of film control can be used such as daily or weekly burnishing with canvas pads, frequent use of light flexible abrasives, or occasional stoning.

It is important that collector rings be given frequent attention because, after film puncture and roughness develop, conditions are apt to become worse at an increasingly rapid rate resulting in proportionate brush wear, and bridging of insulation by brush or metal which finally causes flashover. Other collector ring troubles are quite varied and must be treated as special problems.

3. - HUMIDITY

Low humidity, already described as a problem, is usual in most Bureau powerplant locations. The approximate amount of moisture needed is shown by the minimum safe water content line on the humidity chart (fig,. 1), which has been fixed at 3.43 g/m^3 (1.5 gr/ft^3). Relative humidity is not the indicator to be used here, as less water can be held by air at Iow temperatures. For example, air at-6.7 °C (20 °F) may be tested to have 30 percent relative humidity but the actual water content would be less than needed for good commutator or ring performance. Warming this air for example to 21.1 °C (70 °F) moves you on the chart horizontally to about 12 percent relative humidity, but this does not increase the absolute humidity or water content.

The influence of humidity on brush wear is hard to identify because of the delay in appearance of its symptoms. Once a good film has formed it will last from 1 to 3 months of inadequate humidity with no adverse results. However, if this persists, increased brush friction could wear through the film, especially if film formation is reduced by light load operation. Current density concentrates at the first bare brush areas, sparking starts, roughness develops, and once started, destruction may occur quickly. Consequently, frequent inspections during cold, dry winter weather are advised. If performance deteriorates, roughness can be controlled by frequent polishing with a light flexible abrasive or occasional stoning. Acceptable performance can be maintained through such a period, even though the ring or commutator may operate for a time without film, until normal conditions are restored.

REFERENCE MATERIAL

The following reference material was originally used for this volume. Much of this material was not extensive, and is no longer available, but is listed here for general interest. Carbon-graphite and Metal-graphite Brushes, by the Research and Technical Staff of National Carbon Company; Hunter-Brown, Carbon Brushes and Electrical Machines, A.M.I.E.E. published by the Morgan Crucible Company, Ltd., Battersea Works, London; Commutator and Slip-ring Maintenance, by Ideal Industries, Inc., Sycamore Illinois; Carbon Brushes and Commutator Maintenance (B-6150A), Westinghouse Electric Corporation; Better Carbon Performance (GEA-6688), General Electric Company.