8.3 Shaft current and voltage

Shaft currents can flow in rotating machinery as a consequence of electromagnetically developed voltages in the shaft or frame.

In electrical machines, any unbalance in the magnetic circuits, or in the electrical phase currents that encircle a shaft, can create flux linkages with the rotating system. When the shaft rotates, these linkages can produce an electric potential difference between shaft ends. This voltage is capable of driving a circulating current in a shaft-to-frame loop by using two bearings to complete the circuit.

If the opposite drive end bearing (or both bearings) is/are isolated from the frame, the conducting path is impeded by the insulation, and the circulating shaft current in that machine is inhibited. If only the drive end bearing is insulated, however, the current may be able to circulate by using the opposite end bearing in conjunction with an uninsulated bearing in the interconnected equipment to complete the circuit.

8.3.1 Test to measure shaft potential for circulating shaft currents

In machines that have insulation on all bearings (or all but one bearing), a test can be conducted to detect the presence of shaft potential while the unit is operating. This test can also be applied to machines that have insulating properties in all bearing oil films.

The test is completed by measuring the shaft potential to the frame at each of the other bearings. A high impedance oscilloscope should be utilized and connected with one lead grounded to the frame and the other lead attached to a shaft brush. This brush is then applied to a shaft section near each bearing and the peak voltages are measured. First, a shaft brush is used to short out the uninsulated bearing (or one bearing, if all are insulated). This fixed brush is applied to the shaft near the bearing and connected to the frame with a short piece of low-resistance conductor.

It is preferable to use a low-impedance shielded conductor for the oscilloscope leads to minimize electromagnetic interference. This shield should be grounded at one end only.

If an oscilloscope is not available for the test, a high-impedance voltmeter can be used. Both ac and dc voltages should be measured at each bearing. The peak voltage can be roughly approximated by adding the dc level and 1.4 times the ac rms level. This estimated peak voltage, however, may be considerably below the actual peak value.

An alternate method involves measuring the ac voltage with brushes contacting opposite ends of the shaft while the machine is operating at rated voltage and speed.

8.3.2 Test to measure possible level of shaft current

This test can be conducted on machines as described in 8.3.1. The procedure is identical to that of 8.3.1, with the exception that a low-resistance ammeter is used in place of the oscilloscope.

NOTE—In this test arrangement, the ammeter is being used as a low-impedance, uncalibrated voltmeter. The meter readings may not be a true indication of the current that might flow should there be a breakdown of the lubrication film in the bearing(s). This method may be useful if a history of results from similar tests is available.

8.3.3 Other methods

If special means for measurement of shaft currents, such as Rogowski loops, are a feature of the machine under test, these may be used in lieu of or to supplement the above test methods.