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Large electric machine partial discharge (PD) testing

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PD testing: – A helpful maintenance tool for large electric motors and generators.

Mechanical components such as bearings and couplings are the biggest contributor to the failure of large electric motors and generators (refer to Figure 1). Although insulation system failures historically occur less often, such failures can result in more serious damage and significantly higher financial losses. Detecting the warning signs for these failures is the focus of partial discharge testing.

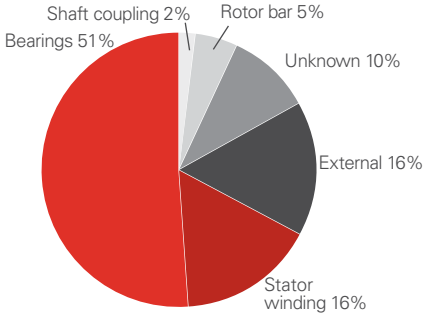

Figure 1: Typical distribution of large electrical motor and generator failures

The integrity of electrical insulation for the stator windings of motors and generators is critical. Unfortunately, this insulation can deteriorate from thermal, mechanical and environmental stresses (refer to Figure 2). For high voltage electric motors and generators (3.3 kV and greater), these failures can be catastrophic and potentially result in fire and mechanical damage to the other equipment within the drive train.

Stator windings are made up of a series of copper conductors individually wrapped in "paper" insulation consisting of mica, binder and resin.

Figure 2: Large motor stator winding insulation failure. Photo courtesy of Machinemonitor Pty Ltd

The paper insulation has a finite life, however premature failures can be caused by overheating, moisture, contamination, mechanical vibration, voltage surges and manufacturing defects, all of which lead to flaws and voids within the insulation layers. Eventually, small electrical pulses between conductors will begin to occur. This is known as "partial discharge". Using special equipment, the severity and location of the fault can be determined well in advance of an actual failure. This process is known as partial discharge (or PD) testing.

There are many other methods for testing the condition of insulation including insulation resistance, power factor and polarisation index testing. However, PD testing is the only method that can be carried out while the machine is running. In fact, installation of special PD couplers on the machine enables continuous condition monitoring and advanced failure prediction. PD testing also provides greater capability in pinpointing the location of the fault.

The modern manufacturing process for electrical motors and generators includes a step referred to as "vacuum impregnation". In this step, the machine is placed in a vacuum chamber to allow resin to fully impregnate the insulation system. Air voids can occur if this process is not properly carried out (refer to Figure 3) resulting in premature failures. PD testing can readily identify these defects, which is why it is recommended as a valuable quality assurance tool in the purchase of new large electrical motors and generators or after rewinds.

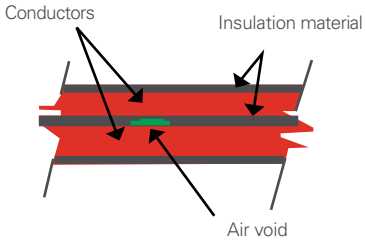

Figure 3: Air void due to manufacturing defect

A summary of the benefits of PD testing for large motors and generators include:

- avoidance of in-service failures and potential consequential losses due to fire and mechanical damage to connected equipment
- early identification of the fault source and likely failure mechanism to allow proper shutdown planning
- use as quality assurance tool in the purchase of new machines or after rewinds
- no need to stop the machine to conduct testing.

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