An Experimental Insulation Testing Investigation of 210 MW Generator: A Case of Thermal Power Station Jamshoro

Mahendar Kumar, Department of Electrical Engineering, MUET Jamshoro, Pakistan
Z.A. Memon, Department of Electrical Engineering, MUET, Jamshoro, Pakistan
M.A. Uqaili, Department of Electrical Engineering, MUET, Jamshoro, Pakistan
Mazhar H. Baloch, Department of Electrical Engineering, MUET, Khairpur Mirs Campus, Pakistan

ABSTRACT

This article describes how a drastic failure of a machine is caused by insulation collapse which results heavy interruption as well as losses. The stable operation of a generator mainly depends upon the stator winding insulation. In past, various testing and repairing techniques have been applied in order to analyze the insulation life. However, in this context, a complete stator windings insulation analysis have been carried out by testing and monitoring techniques such as insulation resistance, di-electric absorption ratio, polarization index before repair and after rehabilitation work, ac & dc high voltage, dc resistance test of winding coils, as well as surface potential test, no-load test and short circuit test. It basically reflected the insulation life of stator winding and helped to take remedial measures. This research techniques will pave the way to overcome such failure in machine and recommended the interval based tests for safety purpose.

KEYWORDS

Flashover, Generator, Insulation, Stator Winding, Testing

1. INTRODUCTION

Insulation breakdown is the major element for damage of generator stator windings due to the cumulative impact of different forces that are thermal, electrical, mechanical, chemical and environmental while in long periodic operations (Kim, 2002, 2004). Investigative techniques are employed in Korea for analyzing the working conditions of insulation medium of the machine under consideration for attaining results from different tests (Ikeda and Fukagawa, 1988). Various online and offline investigation techniques have been established over the period of time for keeping an eye on the insulation of winding ensure the stable working of the electric machines (Sedding, Schwabe, Levin, Stein & Gupta, n.d.). Moreover, diagnosis of winding insulation given in (Penrose, 2001). For instance, in an offshore refinery, the runtime losses owing to motor disruption can be steeped in $25,000/h (Gupta & Stone, 2009). It is very well understood by the industrial sector that poor motor

DOI: 10.4018/IJEOE.2018100104
efficiency leads to escalated energy costs (Tallam, Lee, Stone, Kliman, Yoo, Habetler, & Harley, 2007). Different pressures such as electrical, physical, chemical and environmental alleviate winding insulation. Moreover, the advancements in the fields of sensor technology, digital signal processing, communications systems and integrated circuits have helped modern engineers and technicians to evolve testing methodology in order to supervise insulation systems (Stone, 2005). A number of standards addressing monitoring, testing and evaluation of electrical machines have been authored. Many questionnaires and check sheets developed for motor investigation represent increasing research focus in this area (Stone, 2004). These diagnostic procedures can be generally decoded into two different groups online and offline testing procedures important is which methods have any negative impact on the machines itself. Noninvasive techniques are always on a priority basis as only voltage and current measurements. Insulation breakdown is the top tier cause towards the failure of the entire insulation withstanding and utmost importance. This paper considers, in particular, those faults and their detection that are causing insulation breakdown of machines (Grubic, Aller & Lu, 2008). The necessity for future advancement in this field (Guide for Insulation, 2016), for insulation testing of large ac rotating machinery followed by IEEE practice during high voltage at very low frequency (Mojsoska, 2005). For insulation testing of ac electric machinery followed by IEEE practice during high direct voltage and insulation tests of the generator, motor during overhauling (Gupta et al., 2009; Mojsoska, 2005; Penrose, n.d.; Sedding, Schwabe, Stein & Gupta, 2003). For testing stator high-potential (winding hi-pot) with AC & DC voltages in (Mojsoska, 2005; Penrose, n.d.; Sedding et al., 2003; Olubiwe, Ogbogu, Dike, and Uzoechi, 2014; Test procedures for Synchronous, 1995; Zhu, Morton and Cherukupalli, 2006; Siddique, Yadava, and Singh, 2005; Lee, Younis & Kliman, 2005; Werynski, Roger, Corton, and Brudny, 2006; Kliman, Premerlani, Koegl, and Hoeweler, 1996; Kohler, Sottile, and Trust, 2002; Mirafzal, Povinelli, and Demerdash, 2006). Guideline for all test and electronic circuit analysis of static winding in dynamic machines and power transformers in (Penrose, n.d.). Information on all test instrumentation required for synchronous machine testing during overhauling in (Olubiwe et al., 2014). Turbo-generator 3-phase S.C modeling and measuring parameters for improved performance in (Test Procedures for Synchronous, 1995) and synchronous machines test procedure, performance and acceptance parameter and for dynamic analysis determination in (Zhu et al., 2006). Stator winding insulation failure caused forced outage of generators so financial loss occurs due to high repair cost, production loss and dielectric breakdown failure during operation (Siddique et al., 2005). An induction motors stator fault monitoring techniques review (Lee et al., 2005) and for monitoring condition of insulation an online technique of ac machine stator windings in (Werynski et al., 2006). In ac motors aging of the stator winding insulation for in-service monitoring a new method described in (Kliman et al., 1996) and in ac motors for online turn fault detection new method and stator windings monitoring condition of voltage mismatch detectors are given in (Kohler et al., 2002; Mirafzal et al., 2006). Through pendulous oscillation demonstration of inter-turn fault analysis (Penman, Sedding, Lloyd, and Fink, 1994) during operating motors recognition and location of inter-turn short circuits in stator windings and monitoring given in (Stone and Kapler, 1998). In order to find the generator and motor partial discharges developed through an automatic monitoring system for continuous partial discharge (Maughan, 2004). Generator service failures and its root cause diagnostics in (Liese and Brown, 2008). A great achievement for high voltage windings by designing slot discharge, vibration sparking in (Dymond, Stranges, Younis, and Hayward, 2002) and failures of stator winding due to surface discharge, contamination, tracking in (Rux and Mcdermid, 2001). However, this paper primarily deals with stator electrical testing of 210 MW Unit # 2 of generator type hydrogen stator water cooled and double layer winding. The analysis was carried out after the stator was subjected to a winding flashover and was followed by rehabilitation process. These tests includes insulation resistance (I.R), high voltage (H.V) tests of individual coil, air flow test of stator winding bar, hydro-static test of Teflon tubes, dc resistance test, ac & dc high voltage test of stator, surface potential test, insulation lead creep age test, no-load & short-circuit test of the generator.
System Reliability-based Optimization Method to Solve Unavailability of Electrical Energy
[www.igi-global.com/article/system-reliability-based-optimization-method-to-solve-unavailability-of-electrical-energy/153654?camid=4v1a](www.igi-global.com/article/system-reliability-based-optimization-method-to-solve-unavailability-of-electrical-energy/153654?camid=4v1a)

Fuzzy-Logic-Based Reactive Power and Voltage Control in Grid-Connected Wind Farms to Improve Steady State Voltage Stability