摘要

在電力供應系統中，大型電力變壓器一直是最受重視的工程資產之一，若變壓器在運轉期間由於故障造成電力中斷，對經濟及電力供應之穩定性將造成極大的衝擊及影響。然而，現今針對大型電力變壓器之維修模式，仍然是以當事故發生後的被動性系統維修為主，或是進行週期性的例行性全面維修保養作業，皆無法有效預防突發性事故的發生。因此，大型變壓器在電力系統中之工程資產管理早已成為企業的營運要素，並著重於提前預防與即時診斷維護，以避免突發事故之發生。

本研究以油浸式變壓器為研究標的，首先找到影響變壓器運作狀況及壽命的關鍵工程參數，針對壽期預測提出以邏輯斯迴歸和韋伯分配等理論為基礎的壽期評估方法，建立工程資產壽命評估模型，用以預測變壓器之剩餘壽命。本研究分別為 33 kV、69 kV 及 161 kV 等級之變壓器，以油中溶解氣體、糠醛量及正異常狀態為輸入值，依不同等級建立相對應的邏輯斯模型，再用此模型計算各筆數據之失效機率，用以配適單台變壓器的生命週期曲線，進而計算該變壓器之已耗損年限、壽期及剩餘壽命。另外並整合 IEEE (Institute of Electrical and Electronics Engineers) 之 Doernenburg 診斷法、Rogers 診斷法以及 IEC (International Electrotechnical Commission) 所制定之 Duval Triangle 診斷法等三種油中氣體分析法，診斷變壓器內部可能的故障，提供交叉比對之診斷分析。本研究將提出以遠端即時監控資訊為基之大型電力變壓器智慧型維護支援平台，包含工程參數資料之即時監控、故障診斷模組與壽期預測模組之建立。其中即時監控模組可以隨時監控變壓器的歷史數據，觀察其趨勢，監控項目包含油溫、線溫、周溫、電壓、電流、濕度、壓力、負載、油中溶解氣體各分量及總量等。本研究之決策支援平台與變壓器的監控設備連線，即時將設備狀態資料導入資料庫中，並實際收集 33 kV、69 kV 和 161 kV 等級之變壓器數據，以利做為導入並測試系統平台的案例

分析。本研究提供剩餘資產壽命之精準評估模組，以及智慧型維護管理模組，以利高價值工程資產 (變壓器為例) 之最佳運用。

關鍵詞： 工程資產管理、生命週期預測、邏輯斯迴歸、韋伯分配

Abstract

Large sized engineering assets such as power transformers are important parts of the power supply chain. If there is a shutdown during transformer operation, the economy and stability of the power supply will suffer a huge impact. Therefore, transformers are the critical parts of power systems and their engineering asset management is a critical concern. In order to prevent sudden power shut downs, it is essential to diagnose and detect signs of potential faults and maintain or fix the problems immediately. Hence, we study oil-immersed transformers as an engineering asset in this research. We identify the key factors influencing transformer optimal operating conditions and asset management lifespan. Then, this research develops innovative real-time transformer lifespan forecasting approaches based on logistic regression and the Weibull distribution. Further, using dissolved gas analysis (DGA) based on the three methods, i.e., Doernenburg, Rogers (revised by Institute of Electrical and Electronics Engineers, IEEE) and Duval Triangle (described in the International Electrotechnical Commission (IEC) document), we can diagnose potential transformer malfunctions and provide maintenance suggestions. Finally, this research proposes an intelligence maintenance recommendation platform including real-time condition monitoring, failure diagnostics, and lifespan forecasting modules. The platform helps engineering asset managers quickly compile the data that are collected from the real-time remote monitoring equipment and regular sampling reports, analyzes the transformer's default types and lifespan evaluation, and provides emergency measurements. The research methodology and system modules are evaluated and verified with data from a series of 33 kV, 69 kV, and 161 kV transformers. Thus, decision makers better control and maintain the big transformer engineering assets of high value, minimize unexpected failures and shutdowns, and extend the life of these

assets toward optimal usage.

Keyword: Engineering Asset Management, Life Cycle Prognosis, Logistic Regression, Weibull Distribution.