Estimation of transformers health index based on condition parameter factor and hidden Markov model

ABSTRACT

This paper presents a study to estimate future Health Index (HI) of transformer population based on Hidden Markov Model (HMM). In this paper, HI was represented as hidden state and the condition parameter factors in the HI algorithm namely Dissolved Gas Analysis Factor (DGAF), Oil Quality Analysis Factor (OQAF) and Furfural Analysis Factor (FAF) were represented as the observable states. A case study of 1130 oil samples from 373 oil-typed distribution transformers (33/11 kV and 30 MVA) were examined. First, the mean for HI in each year was computed and the transition probabilities for the condition data were obtained based on non-linear optimization technique. Next, the emission probabilities for each of the condition parameter factors were derived based on frequency of occurrence method. Subsequently, the future states probability distribution was computed based on the HMM prediction model and viterbi algorithm was applied to find the best optimal path sequence of HI for the respective observable condition. Finally, the predicted and computed HI were compared to the hypothesized distribution. Majority of the predicted HI agrees with computed HI. Predicted HI based on OQAF records the most accurate estimation throughout the sampling years. Inconsistencies are observed in year 2 and between year 7 and 10 for the predicted HI based on FAF. The predicted HI based on DGAF is in line with the computed HI during the first 2 years and deviates at the later stage of the sampling period.

Keyword: Hidden Markov model (HMM); Health index (HI); Nonlinear optimization; Transition probabilities; Remaining useful life (RUL)