

## **Application of Markov Model to estimate individual condition parameters for transformers**

### **ABSTRACT**

This paper presents a study to estimate individual condition parameters of the transformer population based on Markov Model (MM). The condition parameters under study were hydrogen (H<sub>2</sub>), methane (CH<sub>4</sub>), acetylene (C<sub>2</sub>H<sub>2</sub>), ethylene (C<sub>2</sub>H<sub>4</sub>), ethane (C<sub>2</sub>H<sub>6</sub>), carbon monoxide (CO), carbon dioxide (CO<sub>2</sub>), dielectric breakdown voltage, interfacial tension, colour, acidity, water content, and 2-furfuraldehyde (2-FAL). First, the individual condition parameter of the transformer population was ranked and sorted based on recommended limits as per IEEE Std. C57. 104-2008 and IEEE Std. C57.106-2015. Next, the mean for each of the condition parameters was computed and the transition probabilities for each condition parameters were obtained based on non-linear optimization technique. Next, the future states probability distribution was computed based on the MM prediction model. Chi-square test and percentage of absolute error analysis were carried out to find the goodness-of-fit between predicted and computed condition parameters. It is found that estimation for majority of the individual condition parameter of the transformer population can be carried out by MM. The Chi-square test reveals that apart from CH<sub>4</sub> and C<sub>2</sub>H<sub>4</sub>, the condition parameters are outside the rejection region that indicates agreement between predicted and computed values. It is also observed that the lowest and highest percentages of differences between predicted and computed values of all the condition parameters are 81.46% and 98.52%, respectively.

**Keyword:** Markov Model (MM); Condition-Based Monitoring (CBM); Condition parameters estimation; Non-linear optimization; Chi-square test; Percentage of absolute error