EFFECTIVE WAY FOR THE IMPROVEMENT OF EFFICIENCY AND THERMAL
WITHSTANDING CAPACITY OF THREE PHASE SQUIRREL CAGE INDUCTION MOTOR
BY COATING THE WINDINGS WITH Al₂O₃ NANO FILLER MIXED ENAMEL

D. Edison Selvaraj¹, C. Ruban Karthik², R. Arun³, V.Vengatesh⁴, M.Rajkumar⁵, S. Geethadevi⁶, Lieutenant J.Ganesan⁷

¹AP/EEE, Panimalar Engineering College, Chennai, India
²B.E-III Year/EEE, Mepco Schlenk Engineering College, Sivakasi, India
³B.E-III Year/IT, Mepco Schlenk Engineering College, Sivakasi, India
⁴B.E-III Year/EEE, Sree Sowdambika College of Engineering, Aruppukottai, India
⁵AP/EEE, Dhanalakshmi Srinivasan College of Engineering and Technology, Chennai, India
⁶Senior AP/EEE, Aurora Scientific and Technological Institute, Hyderabad, India
⁷AP/EEE, Sree Sowdambika College of Engineering, Aruppukottai, India

Abstract

In the recent decades, it was observed that the addition of nano fillers to the enamel can greatly improve the thermal, mechanical and electrical properties of enamel. Al₂O₃ was used as nano filler. The micro particles of Al₂O₃ were converted into nano particles by using ball mill method. Scanning electron microscope (SEM) was used to augment the particle size of the nano powder. The nano filler was mixed with enamel by using ultrasonic vibrator. The enamel filled with Al₂O₃ nano filler was coated on the windings of the three phase induction motor. The performance analysis of the three phase induction motor was carried out by no load test, blocked rotor test and load test. Based on the calculations and result obtained by the above tests, the efficiency of the induction motor coated with enamel filled with nano filler of Al₂O₃ was increased by 4% when compared to that of induction motor coated with pure enamel. Heat run test was also done on this motor to determine the total loss of energy dissipated as heat. The thermal withstanding capacity of the motor was also improved by 11% by adding Al₂O₃ nano fillers to the motor.

Keywords: 3Φ Motor, Enamel, Nano Filler, Load Test

1. Introduction

In recent days, a great deal of attention has been given to the applications of nano fillers in the field of electrical insulating materials. It has been noted that the use of nano fillers to the enamel can greatly improve the thermal, mechanical and electrical properties of it. The efficiency of the induction motor depends upon the enamel used. For motors, the enamel was used for three purposes: impregnation, coating and adhesion.
efficiency of the induction motor could be increased by adding the nano fillers with the enamel which was used as coating for the windings of the motor. In this paper, the efficiency of the normal three phase induction motor and Al₂O₃ nano filler added enamel coated with the three phase induction motor was analyzed and the results were compared with each other. Heat run tests were performed on electric machines to determine the total loss of energy dissipated as heat. It was a well-known fact that the operating temperature of an electric machine has a very strong relationship with the life duration of the insulation. The enamel used for coating the machine windings were organic in nature and were adversely affected by thermal decomposition.

2. Coating of the Nano Filler added Enamel to the Windings of the Motor
5% of nano powder of Al₂O₃ was taken and mixed with the enamel by using ultrasonic vibrator. Then this enamel was coated on the windings of the three phase induction motor. The specifications of the three phase induction motor were shown below in the Table 1.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>1.5 HP</td>
</tr>
<tr>
<td>Speed</td>
<td>1450 rpm</td>
</tr>
<tr>
<td>Current</td>
<td>3.45 A</td>
</tr>
<tr>
<td>Voltage</td>
<td>415 V</td>
</tr>
</tbody>
</table>

Table 1 Specifications of the three phase induction motor

Figure 1 Al₂O₃ Nano Filler mixed Enamel coated Three phase induction motor

3. Experimental Analysis

3.1 Load Test
The load test was conducted as per the circuit diagram and arrangement shown in the Figure 2 and 3. The output power, current, efficiency, power factor, and speed of the induction motor was measured. The maximum efficiency obtained from an ordinary induction motor was 75%. The maximum efficiency obtained from nano coated induction motor was 79%.

**Figure 2** Circuit diagram for Load test on three phase induction motor

**Figure 3** Circuit arrangement for load test on three phase induction motor

### 3.2 Temperature Test

Heat run test was performed on electric machines to determine the total loss of energy dissipated as heat. It was a well-known fact that the operating temperature of an electric machine has a very strong relationship with the life duration of the insulation. Heat run tests were conducted on this motor as per IEC 60851. The temperature of the motor was measured under different conditions and the readings were shown in the Table 2. The Figure 4 shows the temperature comparison of various motor.

**Table 2** Measurement of temperature

<table>
<thead>
<tr>
<th>Time in minutes</th>
<th>Temperature of ordinary motor</th>
<th>Temperature of Nano coated motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>36</td>
<td>35.5</td>
</tr>
<tr>
<td>4</td>
<td>38</td>
<td>37</td>
</tr>
<tr>
<td>6</td>
<td>41</td>
<td>38</td>
</tr>
<tr>
<td>8</td>
<td>43</td>
<td>40</td>
</tr>
<tr>
<td>10</td>
<td>45</td>
<td>41.5</td>
</tr>
</tbody>
</table>
4. Conclusions

The following observations were clear as per this study:

1. The efficiency of the induction motor was increased by 4% by adding nano filler of $\text{Al}_2\text{O}_3$ to the enamel used as the coating for the windings of the three phase induction motor.

2. The addition of nano fillers to the enamel has increased the temperature withstanding capacity of the induction motor. The thermal withstanding capacity of the motor was also improved by 11% by adding $\text{Al}_2\text{O}_3$ nano fillers to the motor. Hence the life time of the motor will be increased.

5. Acknowledgement

Thank God and His almighty power to finish His research work by using me, my friends and my students for His ultimate work.

Reference


