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Energy Efficient Three Phase Squirrel Cage Induction Motor fed AC Drives

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Abstract: Three phase squirrel cage induction motors consume 60% of industrial electricity. 1% increase in efficiency of all the motors in India will save 500 MW powers which needs the initial generation cost of 2000 crores. The efficiency of an induction motor can be substantially improved by controlling the voltage to frequency ratio (V/Hz). Another method of improving the efficiency of induction motor was coating enameled copper wire filled with Al2O3 nano filler. One such method used in this project was carried out under serious literature survey. Based on the previous project works, actions were taken to use the enamel filled with nano filler as the coating for the induction motor to improve its efficiency. Definitely, there will be a tremendous improvement in the efficiency of the induction motor and hence the motor can be called as “High Efficiency Squirrel Cage Induction Motor”.

Keywords: Induction motor, Enamel, Nano fillers, Load test, Efficiency

1. INTRODUCTION

Induction motors were widely used in fans, centrifugal pumps, blowers, lifts, cranes, hoists and so on. The efficiency of the induction motor depends upon the insulation used [1-3]. For motors, the enamel was used for three purposes: impregnation, coating and adhesion. The efficiency of the induction motor can be increased by adding the nano fillers with the enamel which was used as coating for the windings of the motor [3-6]. In this paper, the efficiency of the normal three phase squirrel cage induction motor and the Al_2O_3 nano filled enamel coated three phase squirrel cage induction motor was analyzed and the results were compared with each other.

2. PREPARATION AND CHARACTERIZATION OF AL_2O_3 NANO FILLER

The micro powders of Al_2O_3 were crushed into nano powders by Ball Mill method. The SEM images of Al_2O_3 before and after Ball Mill show the particle size of the powders. The particle size was augment by SEM images [7-9]. These SEM results show that the prepared particles of Al_2O_3were in the nm range.

2.1 SEM analysis before Synthesization

The particle size of Al_2O_3before ball mill method was shown in Figure 1.

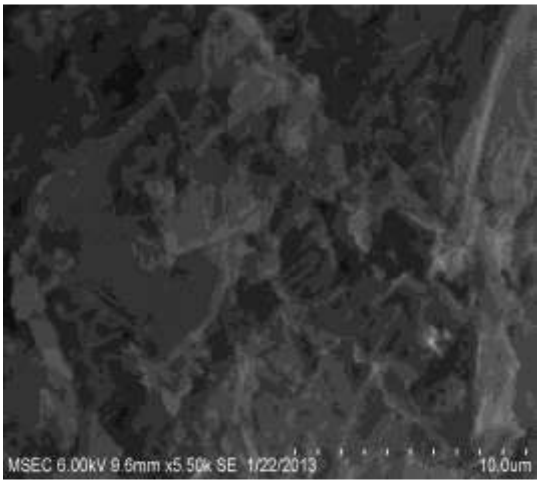

Figure 1 SEM analysis of Al_2O_3 at 10 μm

2.2 SEM analysis After Synthesisation

From the analyzed SEM image the particles were in the form of nano metric range varies for one area to other. The sizes of the particles as shown in figure 2 were in the range from 40 to 100 nm size.

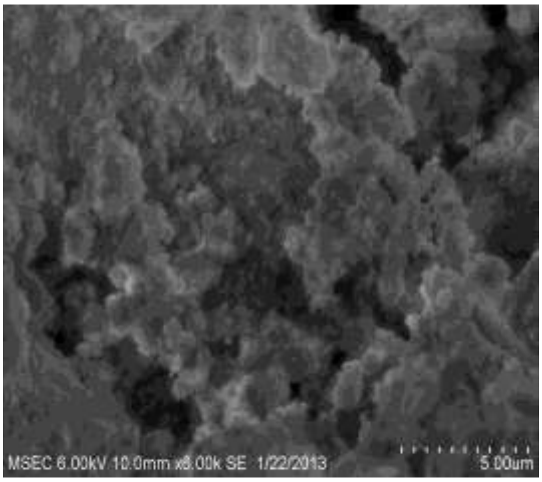

Figure 2 SEM analysis of Al_2O_3 at 5 μm

3. COATING OF THE AL_2O_3 NANO FILLED ENAMEL TO THE WINDINGS OF THE MOTOR

The nano powder of Al_2O_3 were taken and mixed with the enamel by using ultrasonic vibrator [9-12]. Further, this enamel was coated on the windings of the three phase squirrel cage induction motor. The Figure 5 shows the Al_2O_3 Nano filled enamel coated Induction motor.

Figure 5 Al_2O_3Nanocomposite filled enamel coated Induction motor

The specifications of the three phase squirrel cage induction motor were shown below in the Table 1.

Table 1 Specifications of the three phase squirrel cage induction motor

Quantity	Rating
Power	1.5 HP
Speed	1450 rpm
Current	3.45 A
Voltage	415

4. EXPERIMENTAL ANALYSIS

4.1 Performance Analysis of Squirrel Cage Induction Motor – Circle diagram Method

This analysis was done by doing open and short circuit test. By calculating the open and short circuit current and voltage the losses were found using circle diagram method. From the circle diagram it was found that the losses were reduced in nano coated motor. It was shown in the table 2 and 3.

Table 2 Open circuit and short circuit test readings for ordinary induction motor

Open Circuit Test	**Voc**	**Ioc**	**Woc**
	415	1.3	80
Short Circuit Test	**Vsc**	**Isc**	**Wsc**
	95	3.45	210

Table 3 Open circuit and short circuit test readings for Nanocoated induction motor

Open Circuit Test	**Voc**	**Ioc**	**Woc**
	415	1.3	65
Short Circuit Test	**Vsc**	**Isc**	**Wsc**
	95	3.45	180

Figure 6 Snap shot of open and short circuit test

Efficiency was analyzed by conducting load test in ordinary as well stator enameled with nano composite motor [11-13]. The results obtained were successful for nano coated motor. The efficiency of nano coated motor increased to 4 percent. This is mainly due to reduction of dielectric losses in nano coated motor. The readings were calculated for various slip values and shown in Table 4. Figure 7 shows the Efficiency comparison of various motors.

Table 4 Efficiency comparison for ordinary and nano coated motor

Slip	Efficiency of normal induction motor in %	Efficiency of nano coated induction motor in %
0.02	74.95	79.07
0.04	71.5	76.32
0.06	67.50	72.73
0.08	63	67.3
0.1	59.85	63.8

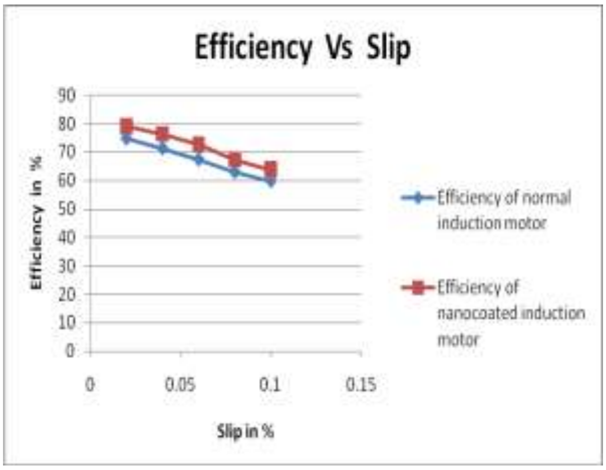

Figure 7 Efficiency comparison of various motors

4.2 Performance Analysis of Squirrel Cage Induction Motor – Direct loading Method

The load test was conducted on the ordinary induction motor and the nano coated indution motor. The performance of the motor were obtained for induction motor by this method. The output power, current, efficiency, powerfactor and speed of the motor were measured during this testing. The maximum efficiency obtained from an ordinary induction motor was 75%. The maximum efficiency obtained from nano coated induction motor was 79%. The efficiency of the motor was increased due to the reduction in harmonic and dielectric losses.

5. CONCLUSION

The efficiency of the induction motor was increased by 4% by adding Al_2O_3 nano filler to the enamel used as the coating for the windings of the three phase squirrel cage induction motor. Hence, the overall performance of the induction motor was also increased by adding Al_2O_3 nano filler to the enamel used in the induction motor. The speed fluctuations were also less and smooth when compared to that of the ordinary induction motor.

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