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Improvement of Efficiency and Thermal Withstanding Capacity of Single Phase Induction Motor

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Abstract: In recent days, it has been shown that the mixing of nano fillers to the enamel can tremendously improve the thermal, mechanical and electrical properties of enamel used in motors. Many nano fillers can be added to the enamel used in the motor. In this research work, SiO2 has been used as nano filler. The micro powders of SiO2 were converted into nano powders with the help of ball mill. Various methods were used to augment the particle size of the nano powders. But, for this research, scanning electron microscope (SEM) has been used to augment the particle size of the nano powders. The prepared nano powders of SiO2 were mixed with enamel by using ultrasonic vibrator. The enamel filled with SiO2 nano filler was coated on the windings of the single phase induction motor. The performance analysis of the single phase induction motor was usually done by means of no load test, blocked rotor test and load test. Based on the results obtained from the above tests, the efficiency of the single phase induction motor coated with enamel filled with SiO2 nano filler was increased by 5% when compared to that of the single phase induction motor coated with pure enamel. Heat run test was also carried out on this motor to determine the total loss of energy dissipated as heat.

Keywords: Single Phase Induction motor, Enamel, Coating, Nano Filler, Load Test, SiO_2.

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1. Introduction

In recent years, a great deal of attention has been given to the applications of nano fillers in the field of electrical insulating materials. It has been examined that the use of

nano fillers to the enamel used in the motors can greatly improve the thermal, mechanical and electrical properties of it. The efficiency of the induction motor depends upon the properties of the enamel used for the coating of the windings of the motor. For single phase induction motors, the enamel was used for three purposes: impregnation, coating and adhesion. The efficiency of the single phase 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 single phase induction motor and SiO_2 nano filler mixed enamel coated single phase induction motor was analyzed and the results were compared with each other. Heat run test was performed on the single phase induction motors to

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determine the total loss of energy dissipated as heat. It was well-known that the operating temperature of the motor has a very strong relationship with the life duration of the insulation. The enamel used for coating of 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

Ball mill method was used to prepare the nano powders of SiO_2. SEM was used to augment the particle size of SiO_2. Figure 1 shows the SEM images of SiO_2 before ball mill process.

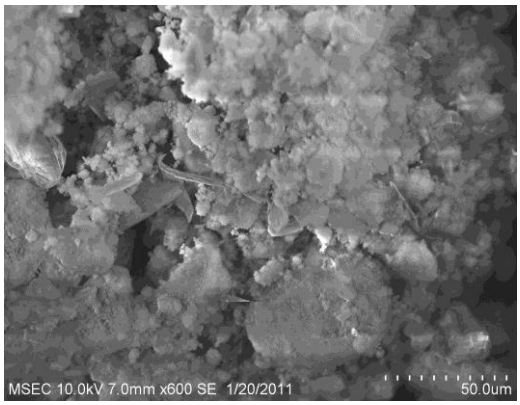

Figure 1 SEM analysis of SiO_2 at 50 μm

Figure 2 shows the SEM images of SiO_2 after ball mill process. The sizes of the particles are in the range from 40 to 100 nm size.

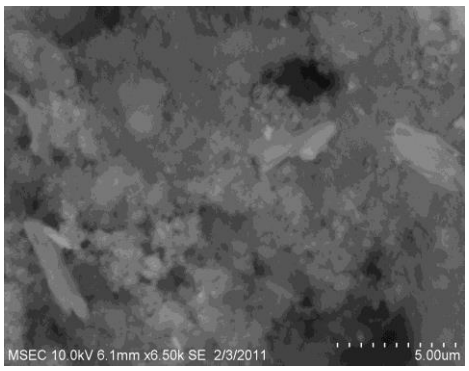

Figure 2 SEM analysis of SiO_2 at 5 μm

5% of nano powder of SiO_2 was taken and it was mixed with the enamel by using ultrasonic vibrator. Then this enamel was coated on the windings of the single phase induction motor. The specifications of the single phase induction motor were shown below in the table 1.

Table 1 Specifications of the Single phase induction motor

Quantity	*Rating*
Power	0.5 HP
Speed	1500 rpm
Current	4 A
Voltage	220 V

3. Experimental Analysis

3.1 Load Test

The load test was done as per the circuit diagram and arrangement shown in the figure 3 and 4. The maximum efficiency obtained from an ordinary induction motor was 69%. The maximum efficiency obtained from SiO_2 nano filler mixed enamel coated induction motor was 74%.

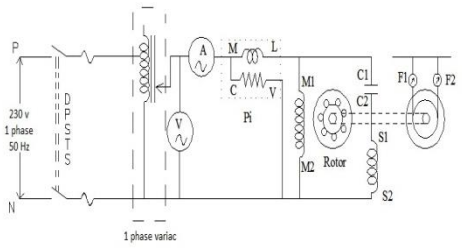

Figure 3 circiut diagram for load test on single phase induction motor

Figure 4 circuit arrangement for load test on single phase induction motor

The output power ,current, efficiency, powerfactor and speed were measured on the ordinary and nano coated single phase induction motor. The readings were shown in the table 2 to 5. Figure 5 shows the Efficiency comparison of various motor.

Table 2 Observed values of V, I, P and N for the normal single phase induction motor

S. No	*Line Voltage (V)*	*Line Current (A)*	*Power (W)*	*Speed (rpm)*	*F_1(kg)*	*F_2(kg)*
1	219.5	3.9	380	1475	1.4	4
2	219.5	4	412	1470	1.5	5
3	219.5	4.2	492	1460	1.6	7.3
4	219.5	4.3	520	1460	1.6	7.6
5	219.5	4.4	548	1455	1.7	8

Table 3 Calculated values of efficiency for the normal single phase induction motor

S. No	*Current (A)*	*Torque (Nm)*	*Input Power (W)*	*Output Power (W)*	*Efficiency (%)*
1	3.9	1.02	380	157.58	41.46
2	4	1.37	412	211.41	51.31
3	4.2	2.23	492	341.96	69.50
4	4.3	2.35	520	359.96	69.22
5	4.4	2.47	548	376.67	68.73

Table 4 Observed values of V, I, P and N for the nano coated single phase induction motor

S. No	*Line Voltage (V)*	*Line Current (A)*	*Power (W)*	*Speed (rpm)*	*F_1(kg)*	*F_2(kg)*
1	220	4	365	1480	5	2
2	220	4.1	410	1478	7	3
3	219.5	4.2	445	1470	9	3.5
4	219.5	4.3	510	1465	10	3.8
5	219	4.4	570	1450	11	3.9

Table 5 Calculated values of efficiency for the nano coated single phase induction motor

S. No	*Current (A)*	*Torque (Nm)*	*Input Power (W)*	*Output Power (W)*	*Efficiency (%)*
1	4	1.172	365	181.55	49.7
2	4.1	1.56	410	224.32	58.85
3	4.2	2.15	445	330.79	74.33
4	4.3	2.43	510	372.60	73.05
5	4.4	2.78	570	421.91	73.85

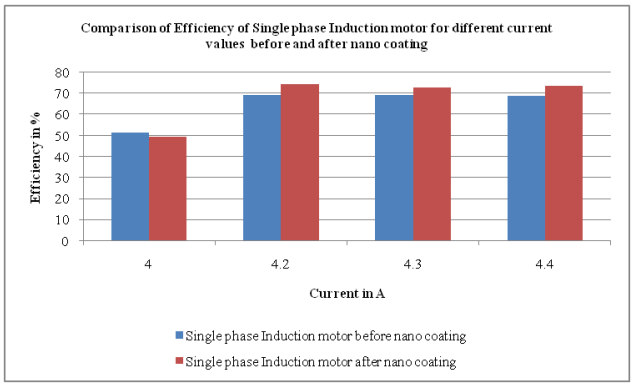

Figure 5 Efficiency comparison

3.2 Temperature Test

Heat run test was done on electric machines to determine the total loss of energy dissipated as heat. It was well-known that the operating temperature of an electric machine has a very strong relationship with the life duration of the insulation. Heat run test was conducted on the single phase induction motor as per IEC 60851. The temperature of the motor was measured under different conditions and the readings were shown in the table 6. Figure 6 shows the temperature comparison of various motor.

Table 6 Measurement of temperature on the windings of the single phase induction motor

Time (min)	*Normal single phase induction motor (^oC)*	*SiO_2 nano filler mixed enamel coated single phase induction motor (^oC)*
0	30	30
5	44	40
10	48	43
15	50	47
20	53	49
25	55	51
30	57	54

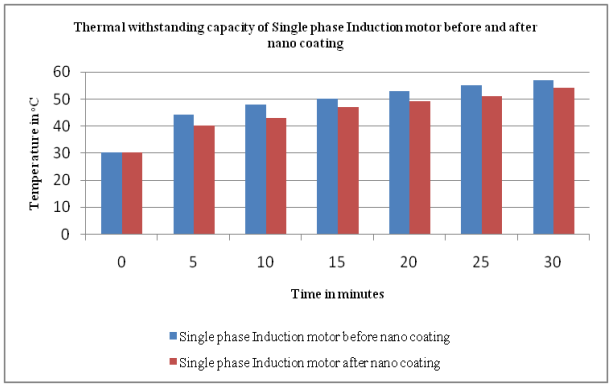

Figure 6 Temperature comparison

4. Conclusions

The following observations were clear as per this research:

1. The efficiency of the induction motor was increased by 5 % by adding nano filler of SiO_2 to the enamel used as the coating for the windings of the single phase induction motor.
2. The addition of SiO_2 nano fillers to the enamel has also improved the temperature withstanding capacity of the induction motor by 13%. Hence the life time of the motor will be increased.

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