

## International Journal of Innovative Research in Science, Engineering and Technology

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# An Analysis of Internal Oil Cooled Induction Motor

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**ABSTRACT:** Induction motors are continuously running in industries for their respective work. Due to continuously operation of induction motors the heat is generated inside the induction motors. It mainly produced between the region of rotor and stator core. This heat generation results in decrease in efficiency, consumption in high voltage and finally the current losses. In future it will results in break down of induction motor. This heat generation requires a proper cooling system in order to reduce the losses which will further results in break downs.

**KEYWORDS:** Induction Motors, Rotor , Stator Core.

### I. INTRODUCTION

Induction motors are widely used in most of production industries. It may contains, paper mill, auto-mobile companies, power plants and any industry where moving parts are there. Induction motors are continuous running in industries for their respective work. Due to continuously operation of induction motors the heat is generated inside the induction motors. It mainly produced between the region of rotor and stator core.

Due to heat generated inside the motor it influences the metal parts due to metal expansions property. It will affect clearance between rotor and stator core which directly increases friction. Due to continuous friction there is increase in heat generation. This heat increases the temperature of copper winding, this temperature rise increases the resistant of the copper & hence it opposes the flow of current which result in high voltage consumption & current losses ( $I^2R$ =losses). In such condition due to high voltage consumption , current losses, increase temperature ultimately shorts the copper winding which breaks down the work of induction motor and it will directly affects the delay in production of industries for their respective work.

The main losses in industries are in electricity, in labor works, in production time and finally it results the economical condition of industry.

### II. DESIGN OF EXPERIMENT

Induction motors are used worldwide in many residential, commercial, industrial, and utility applications. Induction Motors transform electrical energy into mechanical energy.

It can be part of a pump or fan, or connected to some other form of mechanical equipment such as a winder, conveyor, or mixer for power transmission purposes for higher loads. An induction machine can be used as either an induction generator or an induction motor. Induction motors are popularly used in the industry.

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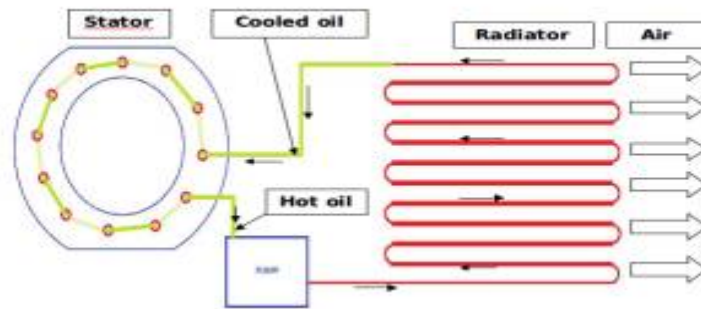


Fig: 1 Internal Oil Cooled Induction Motor

In our experiment we are going to modify the stator of an induction motor with circulation of copper tubes for implementation of our project. As stator is the main part of the induction motor and it is the first which gets heated we decided to provide the cooling system to the stator.

### PARAMETER SELECTION

1. Induction Motor: A single phase induction motor, with capacitor start. It is a half horse power or 0.37 kW with 50 Hz frequency. It has 1420 Rpm and head of 18 meter.

2. Copper Tubes:

(a) 6.1 mm outer diameter & 4 mm internal diameter to be used for oil circulation ii) through stator.

(b) 4.5 mm outer diameter & 3 mm internal diameter to be used for oil circulation through radiator.

3. Coolant In Radiator : We are using oil as a coolant in our project for circulation through copper tubes. The oil has sufficient viscosity and has a high thermal conductivity, so that it can transfer the heat generated from the stator to the radiator where it will be cooled.

4. Electrical insulating oils: Shell Dial S2 ZX-A Oils are electrical insulating fluids, for use in electrical systems where rapid heat transmission and high oxidation stability are required. They are highly refined mineral oils with natural low pour point characteristics. Transformer oil is highly refined oil made for high and low temperature stability. Transformer oil's electrical insulating properties are excellent. Transformer oil is used in oil-immersed transformers, high voltage capacitors, oil radiators power plants. Transformer oils' functions are to electrically insulate, serve as a coolant, resist oxidation and deposit formation, and avoid rusting etc.

### III. EXPERIMENTAL SETUP

The stator of induction motor installed with the copper tubes along with U-tube benders is fixed at one corner of the base table. After motor installation the two ends of copper tubes are taken out so that one of the ends is connected to the radiator outlet. The end of tube is connected to the oil pump reservoir so that the hot oil coming out from induction motor is collected in it. The rotary pump for oil circulation is provided so that the oil sucks from reservoir and is forwarded to the radiator. The outlet of radiator is connected to the induction motor so that cooled oil is forced in it. The temperature gauge is attached at output end of induction motor and at the output end of the radiator so that the temperature differences of hot oil and cooled oil is noted. Through this setup the continuous circulation of oil is carried out so that the heat generated inside the motor is drawn out successfully.

### IV. EXPERIMENT TO BE PERFORMED

Step 1: Working of I.M without Oil Circulation

1. The induction motor is started by connecting to the single phase electric supply. In this step the induction motor runs without the oil circulation i.e. feed pump is off.

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2. The motor continuously runs for some time and the initial and final temperature is noted with the help of thermometer.
3. The temperature difference is calculated by subtracting final and initial temperatures.

Step 2: Working of I.M with Oil Circulation

- 1) The initial temperature of induction motor is noted and the feed pump for oil circulation is started so that the whole copper tubes are totally filled with coolant oil.
- 2) The induction motor is again getting started for some time and the final temperature of oil as well as stator is calculated.
- 3) The heat transfer rate is calculated by difference of final and initial temperature of oil circulated. It will give rate of cooling in our project.
- 4) The temperature difference of stator is also calculated so that the difference in temperature of stator with and without oil cooling is obtained.

### V. RESULT OF EXPERIMENTATION

#### 1. ANALYTICAL RESULTS:

Step 1: Analysis of I.M without internal oil cooling system The readings should be taken on minute basis:

Time (minute)	Temp ( ° c )
<b>T in</b>	<b>T out</b>
At 0.00 min	36.5
At 1.00 min	39.3
At 2.00 min	43.2
At 3.00 min	46.2
At 4.00 min	50.8
At 5.00 min	55.1
T max	=55.1°C

Table:1 Experimental Readings (I.M Without Internal Oil Cooling System)

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Step 2: Analysis of I.M at stable condition with internal oil cooling system.

Time (minute)	Temp ( °c )	
T in	T out	T in
At 0.00 min	36.6	35.3
At 1.00 min	38.5	35.7
At 2.00 min	40.6	36.8
At 3.00 min	42.6	37.4
At 4.00 min	45.3	38.9
At 5.00 min	47.2	39.6
T max	Tmax=47.2	Tmin=39.6

Table:2 Experimental readings (I.M at stable condition with internal oil cooling system)

### VI.CALCULATIONS

According to above two step project analysis of induction motor with and without oil cooling, we got to the result that if we continuously run the induction motor without any extra cooling system i.e. if I.M will start, we found that it will reaches to a maximum temp of 55.1°C.

Similarly if we run induction motor at similar condition with internal oil cooling i.e. with implementation of our project, we see that after same interval of time we got the maximum temp of about 47.2°C which comparatively small. So we practically got the result that we succeeded to achieve cooling of same induction motor with internal cooling by an about 7.9°C.

So finally we can say that the cooling of induction motor is possible with internal oil cooling system. So that the efficiency of induction motor would be increases.

#### Calculation of Heat Transfer Rate

We have theoretical formula for heat transfer rate as follows,

$$\text{Theoretical} = m \times C_p \times \Delta T$$

Where m = mass flow rate of coolant

C<sub>p</sub> = specific heat of coolant

$$\Delta T = T_{\text{max(w/o cooling)}} - T_{\text{max(with cooling)}}$$

We have,

$$m = \rho A v$$

where, ρ = density of oil = 890 kg/m<sup>3</sup>

A = cross sectional area of copper tube

$$= 7.06 \times 10^{-6} \text{ m}^2$$

V = velocity oil = 0.35 m/sec

$$\text{Hence, } m = (890 \times 7.06 \times 10^{-6} \times 0.35)$$

$$= 2.2 \times 10^{-3} \text{ kg/sec}$$

$$C_p = 1.45 \text{ kJ/kg}^\circ\text{C}$$

$$\Delta T = (55.1 - 47.2) = 7.9^\circ\text{C}$$

$$Q_{\text{theoretical}} = (2.2 \times 10^{-3}) \times (1.45) \times (7.9)$$

$$= 0.025 \text{ kJ/sec}$$

$$= 1.51 \text{ kJ/min}$$

And actual heat transfer is given by,

$$Q_{\text{actual}} = \Delta T = (T_{\text{max(w/o cooling)}} - T_{\text{max(with cooling)}}$$

$$= (55.1 - 47.2)$$

$$= 7.9^\circ\text{C}$$

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### VII. COMPARATIVE ANALYSIS

1. From bar chart it is comparatively observed that there is a uniform increase in temperature when internal oil cooling system is not provided to the motor. Whereas for the same motor if internal oil cooling is provided then there is increase in cooling rate in induction motor.

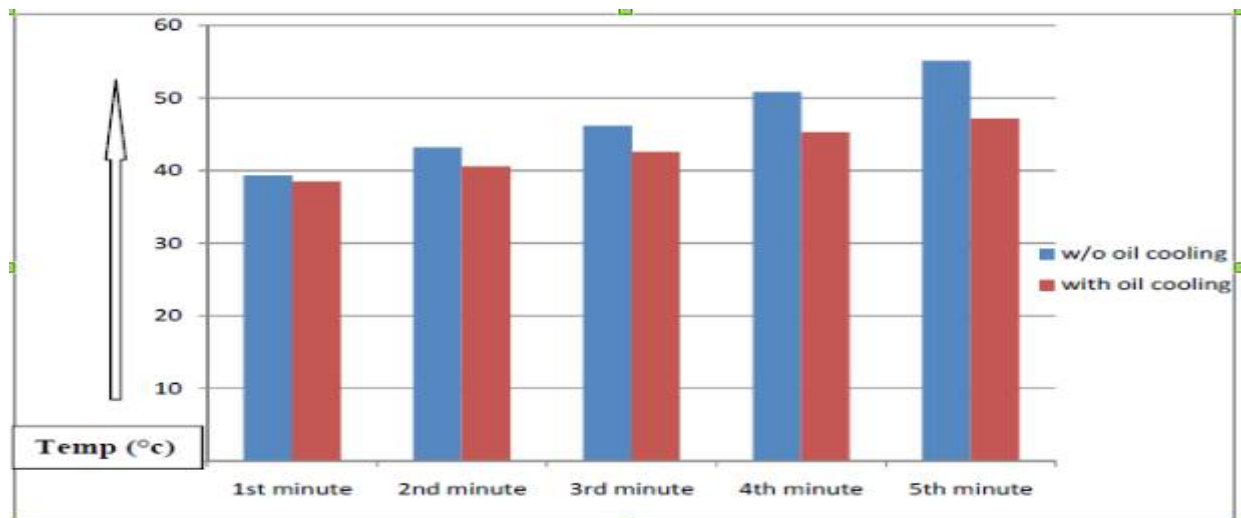


Fig:2 Comparative analysis The observed difference in maximum temperature of motor without cooling and with cooling is obtained so that we can conclude that there is an efficient cooling is achieved.

### VIII. RESULT

1. In our project it is clearly observed that the maximum temperature of induction motor is 55.1°C. when internal oil cooling system was not applied.
2. Similarly, when the internal oil cooling system is implemented in our project it is observed that for the same initial conditions the final maximum temperature is 47.2°C.
3. So the finally it results that the rate of cooling is obtained up to 7.9°C.

### IX. CONCLUSION

As we are trying to adopt new technology, we reach to conclusion that internal oil cooled Induction Motor is boon to all automotive and manufacturing industries.

And we discussed that internal oil cooled Induction Motor system helps to reduce the heat generation of Induction Motor and efficiency of Induction Motor is reasonably increased.

During our study, we found that there may be some complication in general Induction Motor So we come to result that we need such cooling system that can be easy, effective and which will be economic in manufacturing and maintenance.

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