INDEX NO. : M-72

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TECHNICAL MANUAL
FOR

LOAD TEST ON THREE PHASE INDUCTION MOTOR (WITH PANEL)

Manufactured by :

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LOAD TEST ON THREE PHASE INDUCTION MOTOR

AIM : (a) Perform load test on 3-phase induction motor.

(b) Compute Torque, Output power, Input power, Efficiency, Input power factor and Slip for every load setting and to determine how speed, efficiency, power factor, stator current torque, and slip of an induction motor vary with load.

(c) Plot the following performance curves

(i) Efficiency Vs Output power
(ii) Torque Vs Output power
(iii) Line current Vs Output power
(iv) Power factor Vs Output
(v) Slip Vs Output power
(vi) Torque Vs Speed

INSTRUMENTS REQUIRED :

S. No.	Name	Type	Range	Quantity
1.	Ammeter	MI	5A	1
2.	Voltmeter	MI	500 V	1
3.	Wattmeter	Dynamometer	2.5/5A, 150/300/600 V	2
4.	D. O. L. Starter	Push Button Type	For 2/3 HP motors	1

MACHINE REQUIRED :

A.C. Motor 2/3 H.P. 3 Phase 415 V 3.6/4.8 A 1440 RPM with Drum Brake Loading Arrangement.

or

AC Motor 5 HP 3 Phase 415 V 7.5 A 1440 RPM with Drum Brake Loading Arrangement.

THEORY :

The load test on induction motor is performed to compute its complete performance i.e. torque, slip, efficiency, power factor etc. During this test, the motor is operated at rated voltage and frequency and normally loaded mechanically by brake and pulley arrangement from the observed data, the performance can be calculated, following the steps given below.

SLIP : The speed of rotor, N_r droops slightly as the load on the motor is increased. The synchronous speed, N_s of the rotating magnetic field is calculated, based on the number of poles, P and the supply frequency, f i.e.

$$\text{Synchronous speed, } N_s = \frac{120f}{P} \text{ r.p.m}$$

$$\text{Then, slip, } S = \frac{N_s - N_r}{N_s} \times 100 \text{ Percent}$$

Normally, the range of slip at full load is from 2 to 5 percent.

TORQUE : Mechanical loading is the most common type of method employed in laboratories, A brake drum is coupled to the shaft of the motor and the load is applied by tightening the belt, provided on the brake drum. The net force exerted at the brake drum in kg is obtained from the readings S_1 and S_2 of the spring balances i.e.

Output = Torque x Speed

Thus as the speed of motor does not vary appreciably with load torque will increase with increasing load.

Net force exerted, $W = (S_1 - S_2)$ kg

Then, load torque, $T = W \times d/2$ kg – m

$= W \times d/2 \times 9.8$ Nw– m

where, d – effective diameter of the brake drum in meters.

OUTPUT POWER, P_0 : The output power in watts developed by the motor is given by,

Output power, $P_0 = \dfrac{2\pi NT}{60}$ watts

where, N is the speed of the motor in r. p. m.

INPUT POWER : Input power is measured by the two wattmeters, properly connected in the circuit i.e.

Input power = $(W_1 + W_2)$ watts

Where, W_1 and W_2 are the readings of the two wattmeters.

POWER FACTOR : Power factor of induction motor on NO-LOAD is very low because of the high value of magnetising current. With the increase in load the power factor increases because the power component of the current is increased. Low power factor operation is one of the disadvantages of induction motor. An induction motor draws heavy amount of magnetising current due to presence of air gap between the stator and rotor. Thus to reduce the magnetising current in induction motor the air-gap is kept as small is possible.

Input power factor can also be calculated from the readings of two wattmeters for balanced load. If *p* is the power factor angle, then

$$\text{Tan } p = \sqrt{3}\ \frac{W_1 - W_2}{W_1 + W_2}$$

knowing the power factor angle, *p*, from the above, power factor, cos *p* can be calculated. It may be noted clearly at this stage, that the power factor of the induction motor is very low at no load, hardly 0.1 to 0.25 lagging. As such, one of the wattmeter will record a negative reading, till the power factor is less than 0.5, which may be measured by revering the connection of either the current coil or pressure coil of this wattmeter.

EFFICIENCY :

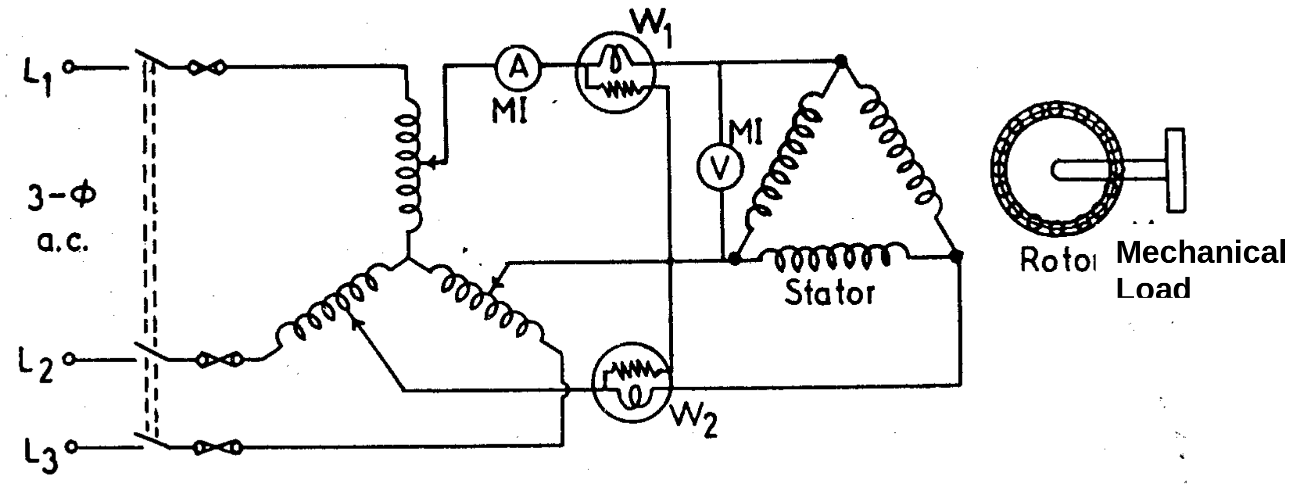
Percentage efficiency of the motor, $n = \dfrac{\text{Output power}}{\text{Input power}} \times 100$

Full load efficiency of 3 phase induction motor lies in the range of 72 % (for small motors) to 82 % (for very large motors).

SPEED : When the induction motor is on NO-LOAD speed is slightly below the synchronous speed. The current due to induced emf in the rotor winding is responsible for production of torque required at NO-LOAD. As the load is increased the rotor speed is slightly reduced. The emf induced in the rotor causes the current increased to produce higher torque, untill the torque developed is equal to torque required by load on motor.

CIRCUIT DIAGRAM :

The circuit diagram of load test on 3 phase squirrel cage induction motor. Instruments connected in the circuit serve the function indicated against each.



Schematic diagram for load test on Three Phase Induction Motor

3 phase variac	- to limit the starting current of the motor
Ammeter	- to measure the current drawn by the stator
Voltmeter	- to measure the voltage across the stator phases
Wattmeters	- to measure input power and power factor

PROCEDURE :

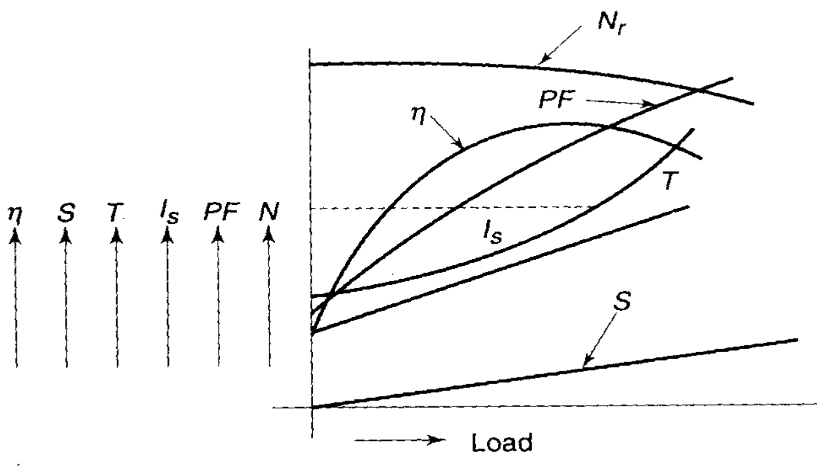
1. Connect the circuit as per fig.
2. Ensure that the motor is unloaded and the variac is set at zero output voltage.
3. Switch-on 3 phase ac mains and start the motor at reduced applied voltage. Increase the applied voltage, till its rated value.
4. Observe the direction of rotation of the motor. In case, it is reverse, change the phase sequence of the applied voltage.
5. Take-down the readings of all the meters and the speed under no load running.
6. Increase the load on the motor gradually by turning of the hand wheels, thus tighting the belt. Record the readings of all the meters and the speed at every setting of the load. Observation may be continued upto the full load current rating of the motor.
7. Reduce the load on the motor and finally unload it completely.
8. Switch-off the supply to stop the motor.
9. Note-down the effective diameter of the brake drum.

OBSERVATIONS : May be tabulated as follows.

S. No.	Line voltage	Input current	W_1	W_2	S_1	S_2	Speed

CALCULATION - May be tabulated as follows.

S. No.	Current	Input power	Torque	Output power	Slip	Power factor	Efficiency



Graphical representation of the effect of load on rotor speed, efficiency power factor, output torque, stator current and slip of an induction motor.

PRECAUTIONS : While loading the induction motor by brakes, check whether cooling water is circulated in the drum. Before starting the motor, loosen the strap and then tighten it gradually when the motor has picked up speed.

WORKING OF CONTROL PANEL

1. Connect the motor and Variac (Optional) as per attached panel layout diagram. On the panel the two wattmeters W1 & W2 are of AE make and are externally connected as per connection diagram given below.

   The three-phase power measurement is conducted by connecting two wattmeters, as shown in fig. The power value is indicated by the algebraical addition of the indication value on the two wattmeters. When the power factor of the circuit being measured is greater than 50%, both meters will indicated "positive" values. The total load power is then calculated by the addition of these two values.

   However, if the power factor of the circuit is less than 50%, one of the two wattmeters will give a negative indication (the pointer will deflect to the left). If this occurs, reverse the voltage connections of the meter with the negative deflection. This and the meter should then indicate on the other meter, to obtain the total load power.

   In duel current range wattmeter for lower current range short the terminal B1 & B2 (series connection) & for higher current range short the terminal B1 -E1 & B2 -E2 (Parallel connection).

2. Ensure that the motor is unloaded and the variac is set at zero output voltage (Optional).

3. Switch-on 3 phase AC mains and increase the applied voltage till its rated value as indicated by the voltmeter.

4. Now start the motor by using manual DOL starter. Press the Green push button for starting.

5. Observe the direction of rotation of the motor. In case, it is reverse, change the phase sequence of the applied voltage.

6. Take-down the readings of all the meters i.e. voltmeter, Ammeter & Wattmeters and the speed under no load running and the weight in Kgs of two spring balances S1 and S2.

7. Increase the load on the motor gradually by turning of the hand wheels, thus tighting the belt. Record the readings of all the meters and the speed at every setting of the load. Observation may be continued upto the full load current rating of the motor (as per name plate data of motor).

8. Reduce the load on the motor and finally unload it completely.

9. Switch-off the supply and push the red button of the DOL starter to stop the motor.

10. Note-down the effective diameter of the brake drum.

OBSERVATIONS : May be tabulated as follows.

S. No.	Line voltage	Input current	W_1	W_2	S_1 (Kg)	S_2 (Kg)	Speed

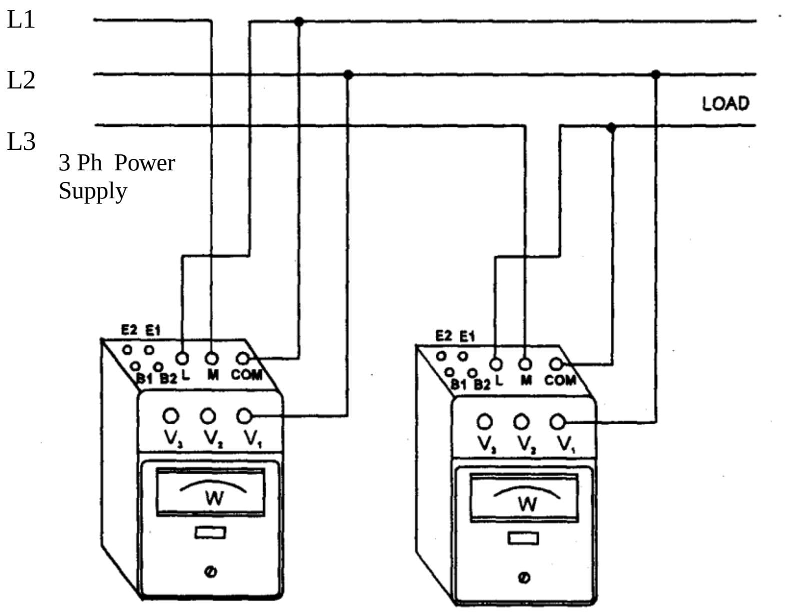
CALCULATION - May be tabulated as follows.

S. No.	Current	Input power	Torque	Output power	Slip	Power factor	Efficiency

N.B The wattmeter shown in Panel are to be connected externally and wattmeters are not supplied along with Panel.

CONNECTION DIAGRAM FOR MEASUREMENT OF POWER BY TWO WATTMETER METHOD

A. **WATTMETERS (Meco make)** :



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However, if the power factor of the circuit is less than 50%, one of the two wattmeters will give a negative indication (the pointer will deflect to the left). If this occurs, reverse the voltage connections of the meter with the negative deflection. This and the meter should then indicate on the other meter, to obtain the total load power.

In duel current range wattmeter for lower current range short the terminal B1 & B2 (series connection) & for higher current range short the terminal B1 -E1 & B2 -E2 (Parallel connection).

PANEL LAYOUT FOR LOAD TEST ON INDUCTION MOTOR