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Measurement of Moment of Inertia by Retardation Test in Three-Phase Induction Motor

Piyali Mondal[1], Somraj Sengupta[2]

[1]Department of EE, Viva Institute of Technology, University of Mumbai
Email: piyaliam@gmail.com
[2]Hysol Renewable Consultants LLP, Mumbai, India
Email: somrajsengupta@gmail.com

***Abstract*—** *In this paper, an experiment is explained thoroughly which demonstrates the process of measuring the moment of inertia for three phase Induction Motor of 5 Hp. The rated speed of the Motor is 1440 rpm. The voltage and current ratings are 440 volts and 7 amps respectively. The method used to get the results is Retardation test. Multiple readings are taken for different values of speed, for calculation of moment of inertia of the machine. Using some standard formula, the final result is obtained. The test set up is set in the laboratory.*

***Keywords*— Electrical Machines AC, Induction Motor, Moment of Inertia, Retardation Test, Drives and Control.**

I. INTRODUCTION

The moment of inertia can be directly found out, when the mass of the different parts of load is known. If the mass of various parts of the load is unknown, then the Moment of Inertia can be obtained experimentally. The method is known as Retardation Test. In a Load-Motor System, it is very important to balance the motor and load torque. The motor toque is balanced by load torque and dynamic torque (J*dwm/dt). Retardation test is usually performed for DC-Motor Drives. But taking certain things into consideration, Retardation Test can also be performed in Induction motor successfully, yielding results good enough to get approximately original value of Moment of inertia.

II. CONCEPT

The moment of inertia is calculated by retardation test. The induction motor drive is run at rated speed. The the supply is cut off. The drive continues to run at rated speed at reted speed due to stored kinetic energy and decelerates due to rotational mechanical loses. The variation of speed with respect to time is noted. At ant speed w_m, power P consumed in supplying rotational lossesis given by

P=Rrate of change in kinetic Energy

$$\text{Or, } P= \frac{d}{dt}\frac{1}{2}JW^2 \quad .....1$$

$$\text{Or, } P= JWm\frac{dW_m}{dt}........2$$

From retardation test $\frac{dW_m}{dt}$, at rated, speed is obtained. The drive is then, reconnected with the supply and run at rated speed. The rotational mechanical power input to thedrive is measured. This is approximately equal to P. now J can be measured from equation 2.

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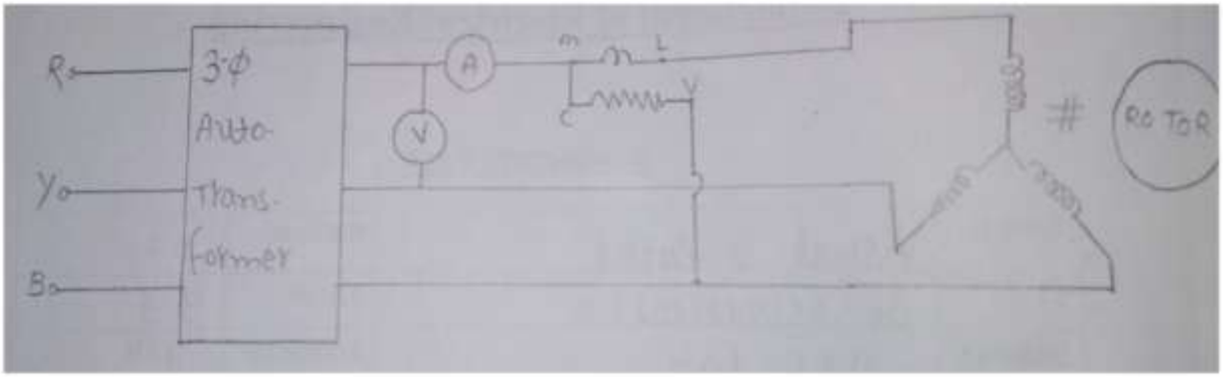

FIGURE 1: circuit diagram of retardation test

III. EQUIPMENT'S USED AND TEST SETUP

The following photograph shows the experiment set up in the laboratory. The photograph clearly shows the equipments required to perform the test.

FIGURE 2: Retardation test set up in laboratory for Experiment

3.1 INDUCTION MOTOR DRIVE

A 5 HP induction motor is used. The rated rpm of the motor is 1440. The motor is provided with 3 phase rated supply. The supply voltage has to be controlled at different stage. In order to get proper value we can use connection involving single phase also.

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3.2 AUTOTRANSFORMER

The supply voltage has to be controlled at different stage. In order to get control the supply voltage autotransformer is used. It is very important for this experiment to run the machine at rated speed.

3.3 MEASURING DEVICES

Three measuring devices used for this experiment are Tachometer to measure speed, Wattmeter to measure power and voltmeter to measure the voltage. We need to record the time with reference to the fall in speed. Time is noted by using stop watch.

FIGURE 3: Measuring devices for experiment

IV. OBSERVATION TABLE AND CALCULATION

TABLE 1
OBSERVATION TABLE

SL.NO	SPEED RPM	TIME SEC
1	1148	5
2	816	10
3	630	15
4	381	20
5	227	25

N= speed in RPM

W= Angular velocity rad/sec= $\frac{2\pi N}{60}$

P= rate of change in kinetic energy= JWm $\frac{dW_m}{dt}$= J $\frac{2\pi N}{60}\frac{2\pi N}{60}\frac{dN}{dt}$

$$\frac{dN_1}{dt} = \frac{816-630}{5} = 37.2$$

$$\frac{dN_2}{dt} = 49.8$$

$$\frac{dN_3}{dt} = 30.8$$

Average= 39.26

P= 160 watts (from measurement)

N= 1440 rpm (from measurement)

160= 1.01xJx1440x39.26

J=0.257 kg/m^3

V. CONCLUSION

In conclusion, we are successful in finding the value in moment of inertia for our induction motor drive, without physically weighing any part of the machine.

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