IJFEAT
INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

Electro-Magnetic Clutch Testing Machine

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***Abstract*-The aim of this project is to design Electromagnetic clutch testing machine which is a machine which indicates the dynamic torque of a electromagnetic clutch. This machine can show the reading of a torque using principle of dynamometer. The operator has to just adjust dimmer stat till the failure of clutch, then circuit is designed in a such a way that it will directly shows the reading of dynamic torque of Electromagnetic clutch. This machine can be easily operated by 24V DC power source.**

Keywords: EM-Electromagnetic Clutch, MVR-Manual Voltage Regulator.

Introduction

The EM Clutch testing Machine is next step after static torque calculating machine. This machine works on principle of simple dynamometer.The dynamometer is used to calculate brake power, dynamic torque, etc. The rotor is driven by the engine or motor under test by mechanical, hydraulic or electromagnetic means and brakes are applied with a same mean. Then by theoretical calculation we can estimate the braking torque. Same principle is used to estimate the dynamic torque of electro-magnetic clutch using setup of display. In this we are calculating dynamic torque of an electromagnetic clutch so using the electromagnetic brake for same caliper.

I. Setup

A. *Electro-Magnetic Clutch*

The electro-magnetic clutch is a clutch which works on principle of electromagnetism. The clutch is actually assembly of two parts that are cup and body. These both are mounted on same shaft but separated by clutch plates with minimum distance of 0.5 mm. The power is provided by mean of, brush and this clutch is coupled with, motor.

B. *Electro-Magnetic Brake*

The electro-magnetic brake is similar to electromagnetic clutch except the clutch plates. Instead of plates it has friction lining. The brake shaft is parallel to clutch and driven by clutch using gears.

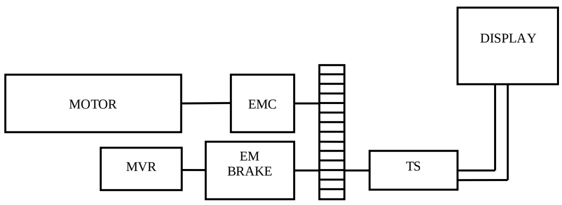

Fig. 1. Schematic setup.

C. *Torque sensor*[5]

Torque sensor is the sensor which gives the amount of reaction torque applied on system. Reaction Torque Sensors have no moving parts so they pick up the reaction torque through system. In the illustrations below we can see where the Rotary Torque Sensor would be used versus a Reaction Torque Sensor in an application involving a motor and break/clutch.

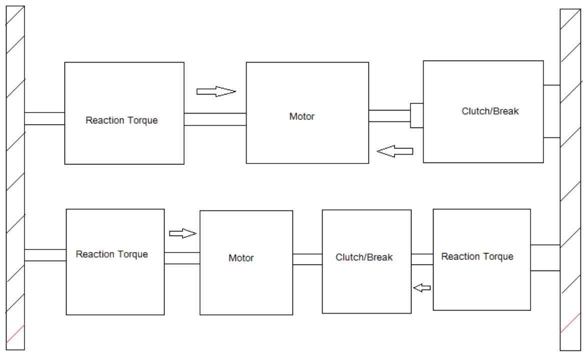

Fig. 2. Application of reaction torque sensor.

D. *Display System*

Display system is used to display dynamic torque of electro-magnetic clutch for the ease of an operator. For display we can use 7 segments LED, 16×4 LCD, etc.

E. *Manual Voltage Regulator*

MVR is a just device which provides the provision to regulate voltage supplied to brake. Here we are using MVR to avoid sudden braking action and damage to gears and clutch. There is one another method to calculate dynamic torque using RPM sensors only so this MVR is also useful in this method.

F. Motor

The motor can be used any standard motor but it should have torque more than static torque. Here we have used 1 HP Foot mounted motor because we have used the clutch with static 8 kg-cm torque by considering some factors like factor of safety and etc.

II. WORKING

The working of this system is based on principal of dynamometer. The conversion of mechanical parameters into electronic parameter using transducers can be done easily which helps to display the parameters. We have two methods for it-

A. Using Torque sensor. B. Using RPM sensor.

A. Using Torque Sensor[6]

Torques can be divided into two major categories, either static or dynamic. The methods used to measure torque can be further divided into two more categories, either reaction or in-line. Understanding the type of torque to be measured, as well as the different types of torque sensors that are available, will have a profound impact on the accuracy of the resulting data, as well as the cost of the measurement.

A reaction torque sensor [2] takes advantage of Newton's third law: 'for every action there is an equal and opposite reaction'. To measure the torque produced by a motor, we could measure it inline as described above, or we could measure how much torque is required to prevent the motor from turning, commonly called the reaction torque.Measuring the reaction torque avoids the obvious problem of making the electrical connection to the sensor in a rotating application, but does come with its own set of drawbacks.A reaction torque sensor is often required to carry significant extraneous loads, such as the weight of a motor, or at least some of the drive line. These loads can lead to crosstalk errors (a sensors response to loads other than those that are intended to be measured), and may dampen dynamic loads of interest, as the sensor has to be oversized to carry the extraneous loads, thereby reducing sensitivity.

Fig. 3. Reaction torque sensor[5]

In-line torque measurements are made by inserting a torque sensor between torque carrying components, much like inserting an extension between a socket and a socket wrench.This method allows the torque sensor to be placed as close as possible to the torque of interest and avoid possible errors in the measurement such as parasitic torques (bearings, etc.), extraneous loads, and components that have large rotational inertias that would dampen any dynamic torques.

Fig. 4. Inline Torque Sensor[6]

Both of these methods, inline and reaction, will yield identical results for static torque measurements. Making in-line measurements in a rotating application will nearly always present the user with the challenge of connecting the sensor from the rotating world to the stationary world. There are a number of options available to accomplish this, each with its own advantages and disadvantages.

In this project we are using reaction torque sensor which is coupled with break shaft after gear.

B. Using RPM Sensor

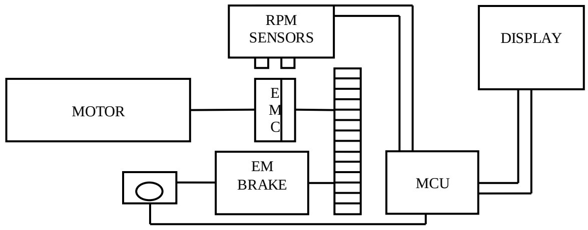

Fig. 5. Schematic of setup using RPM sensor.

These techniques can be used where torque sensor cannot be applicable or not affordable. For this project we have used 2 optical rpm sensor. The basic logic behind this method is as given follow

Torque by brake = Braking torque of clutch

$$P = \frac{2\pi \times N \times T}{60} \qquad (1)$$

Where,

P = Power supplied to brake to fail the clutch, Kw.

N = Speed of a clutch body,rpm.

T = Breaking Torque of clutch, N-m.

The 2 rpm sensors will be installed. One at clutch body and another at clutch cone so both can measure the rpm of cone and body of clutch . Let

N_1 = speed of body of clutch, rpm.

N_2 = speed of cone of clutch, rpm.

If,

$N_1=N_2$ clutch is engaged.

$N_1 \neq N_2$ clutch is disengaged.

Here we have to calculate torque at which clutch get disengage. So when we will apply brake it will resist the motion of clutch, as braking force exceed the clutch torque then clutch will fail also we can identify by N_1& N_2.

Now in programming we can design the program such that the microcontroller will get the rpm of cone which is running with motor after failure of clutch. Then as per the formula (1) the controller will take a reading of power given to brake i.e. V×I and find as well as show the remaining single unknown T(N-m) value of torque on display.

III. Advantages and Disadvantages

A. Advantages

The advantage of this system is that easy to operate, any person can operate the machine very easily and finely. The accuracy is high as compared to other machines in market. Also light in weight so we can call it as a portable machine. Both methods of operation are simple and straight forward.

B. Disadvantages

The main disadvantage is that the magnetic field of clutch and brake may affect the performance of sensors which can reduce the accuracy of system. Second disadvantage is due to the high cost of torque sensors overall product cost may increase drastically as compare to using rpm sensor.

Conclusion.

The paper presents a strategy to get dynamic torque of an Electromagnetic Clutch using dynamometer principle. The proposed setup is different than existing setup available in market. In section II we discussed the overall setup and the components with their required information. In working we have to successful methods for implementation as we can see the method by using RPM sensor is cheaper than the method by using torque sensor. The whole setup is mounted on aluminum casted chassis called as frame. The theoretical calculations are referred as an idle but after testing ofmachines the actual reading will show the actual scenario. Error factor can be estimated and then added in actual calculations. Due to its accuracy, portability of this machine it shows its extraordinariness. By taking the disadvantage in a count we have to replace or repair the sensors after regular period to ensure the accuracy of machine. The whole project is under testing.

Acknowledgement

The work was supported by Magnacore clutch and brakes Pvt.Ltd under the contact of Mr. K. R. Damale.

The work was also supported by SKN Sinhgad Institute of Technology and Science under guidance of Prof.G.S.Datar

Appendics

A. Parameters of electrical machines:

Clutch under test: V=24 V, f=50 Hz, P=108W, n=935 rpm,I=4.2 A, T = 5 Kg-Cm.

Brake Load: V=400 V, f=50 Hz, P=108W, n=1450 rpm,I=4.2 A, T= 8 Kg- Cm.

Total real inertia (including both machines and coupling):

J= 0. 0981 kgm^2

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