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EARLY FAULT DIAGNOSIS IN ELECTRICAL MOTORS USING SIMULINK

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Abstract
The three phase induction motor model is implemented. Stator inter turn fault is created for a balanced and unbalanced condition. Early diagnosis of an interturn short circuit issue while the motor is running will prevent some eventual harm to the coils and stator core, lowering maintenance expenses. The performance under balanced supply conditions is examined in this research.

Keywords: Three phase Induction motor, balanced and unbalanced conditions, inter-turn fault.

1. INTRODUCTION

Induction motors are the most common motor in the world. Induction motor finds its applications in almost all the domains like industrial automation, commercial, domestic, etc. This is mainly because of its added advantage of robustness, simple construction and reliable operation. Along with it,an induction motor has nearly constant speed motor characteristics. Other motors are used only in special-purpose applications where variable speed control is needed. Moreover varied ratings of induction motor are available ranging from KW to thousands of kilowatts. The load characteristics of induction motors can be used to guide their selection. Because it provides information about the motor's horsepower requirements, starting torque, speed variation, duty cycle, and other characteristics.

So that it is easy to match a certain motor grade to a specific application.

During the operation, Induction motors are subjected to various stress leading to an unexpected faults. Hence, condition monitoring of Induction motors plays a vital role t avoid such kinds of unexpected faulty conditions which in turn disturb the entire operation of the system.

Various research and survey has been carried out which concludes that 35% of the faults are generated in the stator winding and around 9% faults in rotor winding. Bearing faults are around 41%. Thus online fault detection have been challenging for engineers.

2. MODELLING OF INDUCTION MOTOR

Simulation studies of electrical motor operation are essential for understanding their dynamic characteristics and electromechanical interactions. An adequate model allows for the simulation of motor failures and, as a result, the modification of related parameters to be predicted without the need for practical experimentation. A three-phase induction motor was simulated and run under normal operating conditions, including section to section winding faults, section to ground winding faults, short circuit winding faults, and voltage imbalances between phases of the offer.
out of all the faults occurring in induction motor, the inter turn faults occurring in the stator is the mostly occurring. Early detection and diagnosis of such fault , will help us to prevent major damage in the Electrical Machines.
the stator voltage equations:

Fig.1 Mathematical model of Induction motor.

$$v_{as} = r_s i_{as} + d\lambda_{as}/dt \quad (1)$$

$$v_{as} = r_s i_{as} + p\lambda_{as} \quad (2)$$

$$v_{bs} = r_s i_{bs} + p\lambda_{bs} \quad (3)$$

$$v_{cs} = r_s i_{cs} + p\lambda_{cs} \quad (4)$$

$$r_{as} = r_{bs} = r_{cs} = r_s \quad (5)$$

The rotor voltage equations:

$$v_{ar} = r_r i_{ar} + d\lambda_{ar}/dt \quad (6)$$

$$v_{ar} = r_r i_{ar} + p\lambda_{ar} \quad (7)$$

$$v_{br} = r_r i_{br} + p\lambda_{br} \quad (8)$$

$$v_{cr} = r_r i_{cr} + p\lambda_{cr} \quad (9)$$

$$r_{ar} = r_{br} = r_{cr} = r_r$$

and

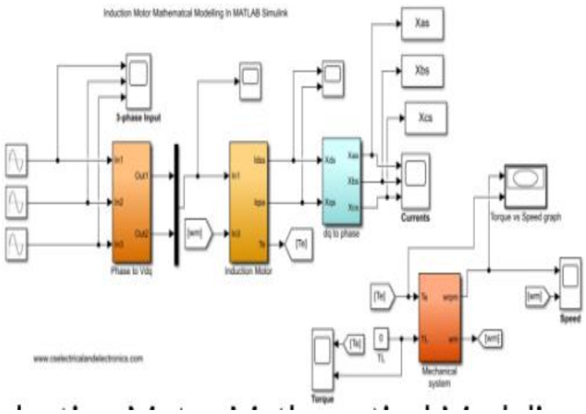
$$v_{ar} = v_{br} = v_{cr} = 0$$

The stator voltage equations can be written as:

$$v_s^{abc} = r_s^{abc} i_s^{abc} + p\lambda_s^{abc}$$

and The rotor voltage equations can be written as:

$$0 = r_r^{abc} i_r^{abc} + p\lambda_r^{abc}$$



3. EXPERIMENTAL SET-UP AND DATA GENERATION

A three-phase, four-pole, 0.5-hp induction motor was used in the experiment, which was connected to a mechanical load through a belt pulley system. The motor connections were wired together, through a Direct-On-Line connection to a three-phase power supply (D-O-L) starter. The experimental setup for data is shown in Fig. 2.Three-phase induction acquisition and condition monitoring motor.[2]

Fig.2 Induction Motor Fault Diagnosis

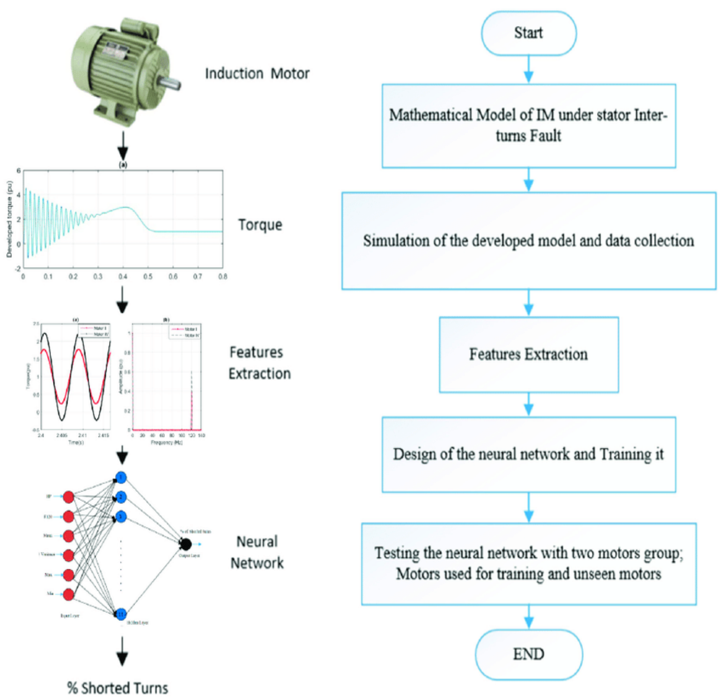
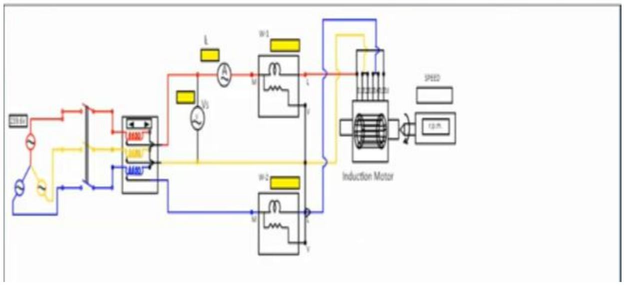


Fig.3 Experimental Set-up



4. **NO-LOAD & BLOCKED ROTOR TEST**

NO-Load test is performed to find out following parameters,

Table. 1 No-Load Test

V (volt)	P1 (W)	P2 (W)	I (A)	N (RPM)	Pin (W)	PF
408	150	240	3.4	1430	360	0.15

Blocked rotor test is carried out to find out following parameters,

Table.2 Blocked rotor test

Rs (ohm)	**Rr** (ohm)	**Ls** (Henry)	**Lr** (Hemry)	**Lm** (henry)	**Rs** (ohm)	**Rr** (ohm)
6.2	7.91	0.481	0.481	0.3942	6.2	7.91

Table.3 Faulty condition parameters

Sl. No	No. of shorted turns	Stator Resistance (ohm)			Rotor Resistance (ohm)	Fault Inductance (Henry)			Rotor Inductance (Henry)	Magnetizing Inductance		
		R_{sa}	R_{sb}	R_{sc}	R_r	L_{fa}	L_{fb}	L_{fc}	L_r	L_{ma}	L_{mb}	L_{mc}
1	1-3	2.3	7.66	3.68	6.1	0.01497	0.05	0.024	0.418	0.390	0.48	0.4
2	3-5	2.08	7.905	3.32	6.1	0.0139	0.052	0.02118	0.418	0.386	0.488	0.389
3	5-7	1.92	8.508	3.20	6.1	0.01266	0.05632	0.01999	0.418	0.381	0.504	0.378
4	7-9	1.85	8.95	3.04	6.1	0.01126	0.05941	0.01851	0.418	0.373	0.521	0.364
5	9-11	1.75	9.40	2.92	6.1	0.01038	0.06251	0.01741	0.418	0.369	0.532	0.357
6	11-13	1.63	9.96	2.86	6.1	0.009475	0.06637	0.0167	0.418	0.362	0.545	0.346
7	13-15	1.52	10.54	2.78	6.1	0.008522	0.0704	0.01545	0.418	0.355	0.564	0.337
8	15-17	1.40	11.1	2.66	6.1	0.007655	0.07425	0.01467	0.418	0.349	0.578	0.329
9	17-19	1.33	11.8	2.59	6.1	0.00679	0.07912	0.014	0.418	0.343	0.590	0.318
10	19-21	1.24	12.5	2.51	6.1	0.006277	0.08404	0.01328	0.418	0.337	0.605	0.309
11	21-23	1.11	13.25	2.40	6.1	0.005659	0.08936	0.01251	0.418	0.331	0.618	0.297
12	23-25	1.02	13.9	2.26	6.1	0.004888	0.09402	0.0116	0.418	0.319	0.631	0.284
13	25-27	0.91	14.30	2.12	6.1	0.004418	0.09698	0.01065	0.418	0.308	0.648	0.271
14	27-29	0.82	14.96	2.01	6.1	0.003825	0.10165	0.00984	0.418	0.294	0.663	0.257
15	29-31	0.71	15.5	1.86	6.1	0.00334	0.10557	0.00886	0.418	0.281	0.678	0.243

5. RESULT & CONCLUSION:

Induction motor was modelled in MATLAB environment and fault was created at 0.5 Sec in phase A. It was observed that, Current in phase A rises to its peak value. Whereas, current is Phase B is less influenced and current in Phase C is has smaller influence compared to Phase A.

Fig.4 current in phase A

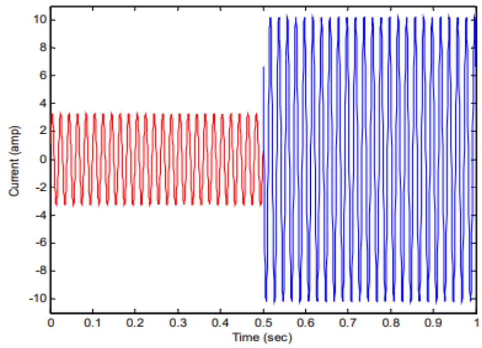


Fig. 5 current in phase B

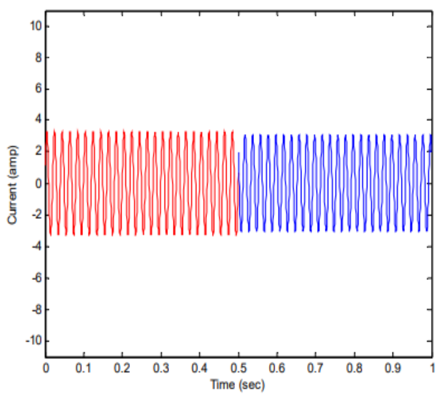
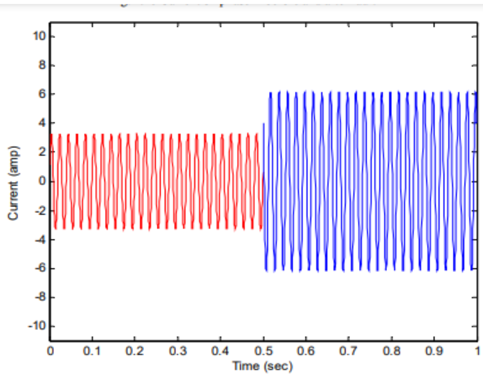


Fig.6 Current in phase C



Under both healthy and stator inter-turn short circuit fault conditions, an experimental setup is established for the development of induction motor parameters such as stator resistance, rotor resistance, stator inductance, rotor inductance, and magnetising inductance. For the purpose of We did various experiments (no-load test, block test) to generate those parameters.

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