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Simulation and Analysis of Three-Phase Asynchronous Motor

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Abstract- This paper presents when unbalanced is introduced in the stator circuit, the result is obtained in the form of unbalanced of stator current , rotor current,torque and speed of the machine. In this study unstaisfactory parameters of stator current , rotor current ,torque and speed via simulation are presents. In this paper single phase supply apply on the two pahses of induction machine.The simulation results are also given which shows the performance of asynchronous (induction) motor.This simulation results justify the abnormality in the speed and torque of the machine.In this study results obtained under unbalance are also compared with the results under balanced condition.

Index Terms- asynchronous motor, simulink, stator current (i_s), rotor current(i_r),speed(ω_m), torque(t_s)etc

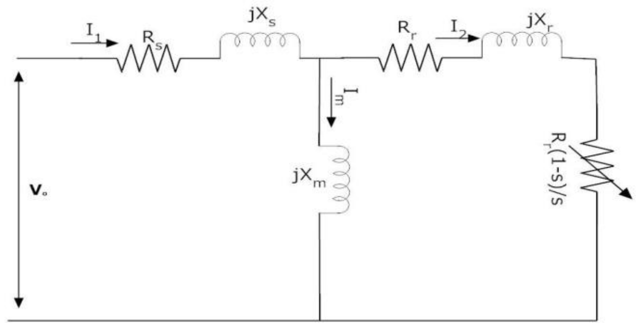
I. INTRODUCTION

Due to their reliability, simple construction and low cost, these motors are widely used in industrial drives. It has good speed regulation and high starting torque. Furthermore, it requires little maintenance. It has a reasonable overload capacity. For industrial and many other application three-phase asynchronous motors are prime movers for the vast majority of machines. In modern industrialized countries, more than half the total electrical energy used in those countries is converted to mechanical energy through AC induction motors. It has also estimated that 70% to 80% of all electricity in the world is consumed by these motors. Due to the recent developments in speed control methods of the induction motor have led to their large scale use in almost all electrical drives. They are truly elegant machines in that there are no moving parts except the rotor. Damage of stator insulation is the most frequent failure in electrical motor. Protection of the induction motor against different internal faults would limit the fault duration and prevent motor from substantial damage, but unbalanced voltage is one of the most frequent disturbances in electrical systems.

II. CIRCUIT MODEL

Considering the three phases to be balanced, when the three-phase voltages are applied to the stator windings, a rotating magnetic field is established. As the magnetic field rotates, currents are induced in the conductors of the squirrel-cage rotor. The interaction of the induced currents and the magnetic field produces forces that cause the rotor to also rotate.

The per phase equivalent circuit of an asynchronous motor is shown below



Where R_s stator resistance , X_s stator reactance, R_r rotor resistance and X_r rotor reactance

Rotor current is:

$$I_2 = \frac{V_0}{\left[\left(R_2 + \frac{R_r}{s}\right) + j(X_s + X_r)\right]}$$

Maximum torque, thus

$$T_{max} = \frac{3V_0^2}{2\omega_s\left[R_r \pm \sqrt{[R_s^2 + (X_s + X_r)^2]}\right]}$$

The rotor circuit of an induction motor has low resistance and high inductance. At starting, the rotor frequency is equal to the stator frequency (i.e., 50 Hz) so that rotor reactance is large compared with rotor resistance. Therefore, rotor current lags the rotor e.m.f. by a large angle, the power factor is low and consequently the starting torque is small. When resistance is added to the rotor circuit, the rotor power factor is improved which results in improved starting torque. This, of course, increases the rotor impedance and, therefore, decreases the value of rotor current but the effect of improved power factor predominates and the starting torque is increased.

III. SIMULATION TEST AND RESULTS

The facilities provided by the Simulink software of MATLAB are used to implement the block diagram. In this study simulation test is performed to measure the effect of unbalanced supply on stator circuit of three phase asynchronous (induction) motor. In this work a squirrel cage asynchronous motor is tested.

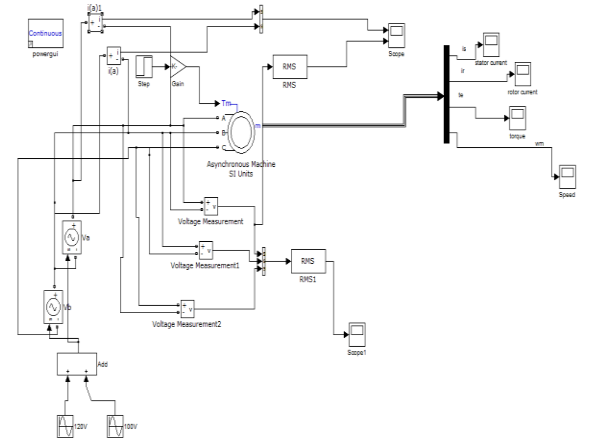


Fig 1 simulation model of 20 hp induction machine when 1 phase supply applied

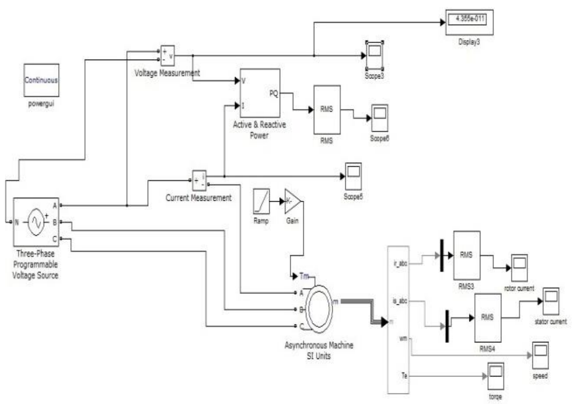


Fig 2 simulation model of 20 hp motor when three phase supply applied

A 20 hp 460V, 1760 rpm motor is used for this purpose i.e. operation is performed on 20hp three phase motor. When the unbalanced is interduced in the stator circuit ,the result can be observed in the form of unbalanced parameter of stator current , rotor current,torque and speed of the machine as shown in figs.

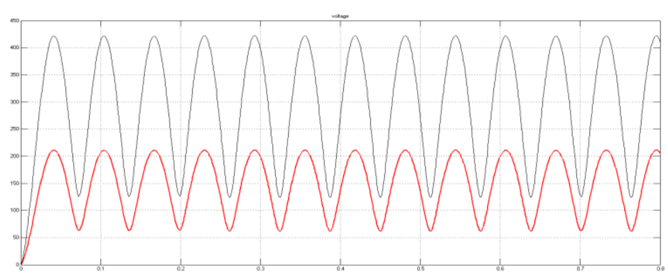


Fig3 voltage between two phases

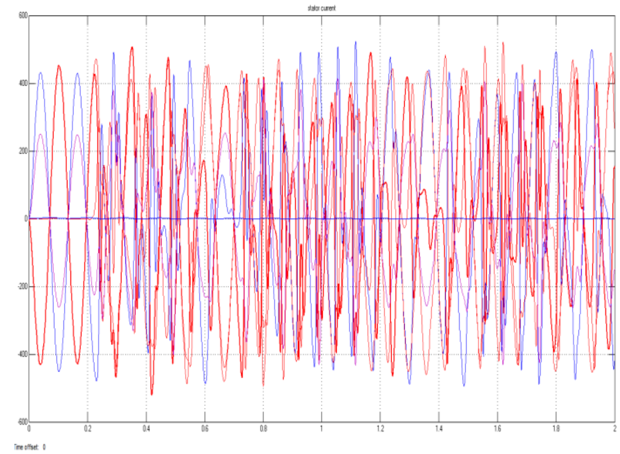


Fig 4 stator current (i_s) under unbalanced voltage condition

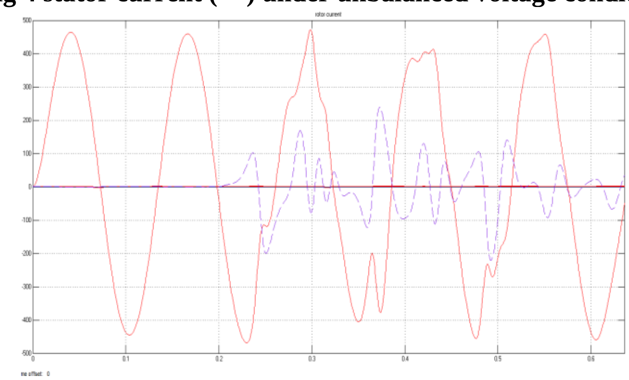


Fig 5 rotor current (i_r) under unbalanced voltage condition

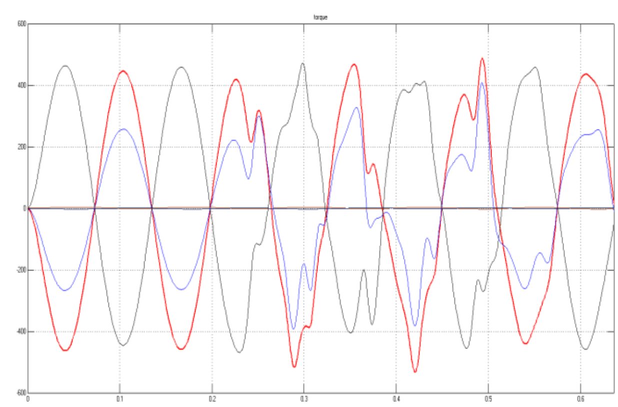


Fig 6 Torque (t_s) curve under unbalanced condition

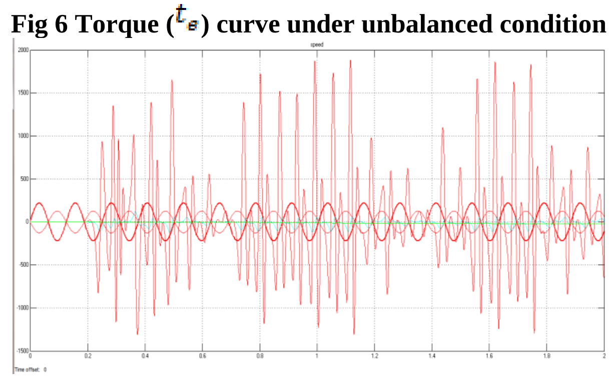


Fig 7 speed(ω_m) when single phase supply apply on two phase of machine

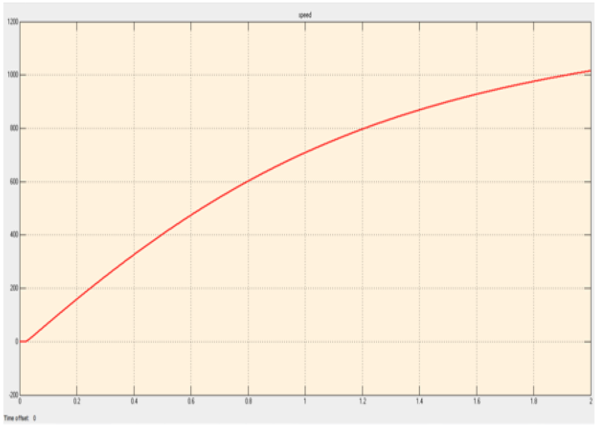


Fig 8 speed (ω_m) when three phase supply apply

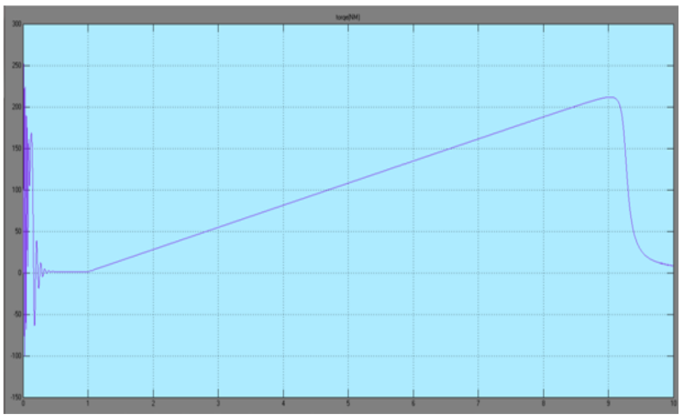


Fig 9 Torque (t_e) curve when three phase supply apply

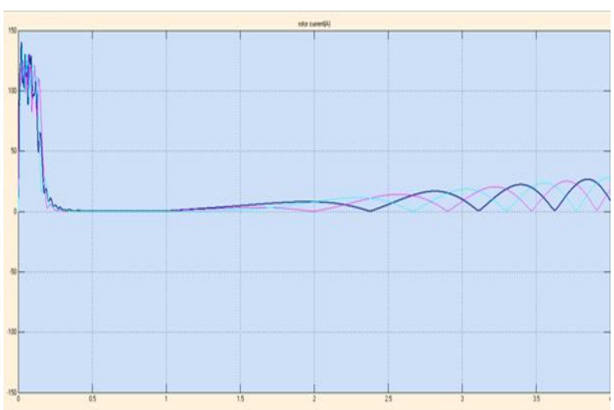


Fig10 rotor current under balanced condition

After studied it is observed that, during starting of an induction motor, the stator resistance and the motor inductance (both rotor and stator) must be kept low to reduce the steady state time and also to reduce the jerks during starting. On the other hand, higher value of rotor resistance leads to lesser jerks while having no effect on the steady state time.

IV. CONCULSION

From the simulink result, it is found that an unbalanced supply voltage produces rotating magnetic field moving at a non-uniform rate and strength. This will cause unbalanced heating in the stator winding, which will lead to unequal heating. The variation in supply voltage affects the speed, torque of the motor, starting current, full-load current, starting torque, maximum torque as well as operating temperature of various parts of the machine. These lead to unsatisfactory operation of the machine. Also the unbalancing in the voltage source can cause excessive losses, heating, noise, vibration, torsional, pulsations, slip and motor accelerating torque.

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