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MODELLING OF DYNAMIC BRAKING IN INDUCTION MOTORS

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ABSTRACT

The three-phase squirrel-cage induction motors are mostly used in industrial drivers since they are rugged, reliable and economical. One of main issues related to induction motors is braking rotor quickly. There are several methods of braking, one of which is dynamic braking. In this paper this method of braking will be shown and analysed using Matlab/Simulink software.

Keywords: Induction motor, dynamic braking, stationary field, Matlab/Simulink, braking time.

INTRODUCTION

The three-phase induction motors with short-circuited rotor (squirrel cage) are mostly used in industrial applications that require fixed speed or variable speed. The induction motors work in two different regimes depending on the direction of energy flow as follows:

- **"motoring" regime**, when the motor rotor turns slower than prescribed speed. In this case, the electrical energy is transformed into mechanical energy at the motor shaft;
- **"generating" regime**, when the motor rotor turns faster than synchronous speed set by a drive output. In this case, the mechanical energy from the motor shaft is transformed in electrical energy [1].

The use of an induction motor requires the process of stopping the motor speed quickly, using mechanically and electrically generated braking torque. Dynamic braking, which is done by making a magnetic field stationary motor. This condition is carried out by injecting a DC current into the three phase induction motor stator coil after the connection of the stator coil is released from the AC supply voltage source. The advantages of dynamic braking include ease of speed regulation of three-phase induction motors and mechanical losses can be reduced.

ANALYSIS AND RESULTS

The direct current injected on the stator coil will develop the stationary field to reduce the voltage on the rotor and produce a magnetic field. The magnet will rotate at the same speed as the rotor but in the opposite direction to make it stationary to the stator. However, the motor must not be connected to a voltage source when zero speed occurs. The torque generated from braking and breaking time depend on the amount of DC current injected into the stator winding [2].

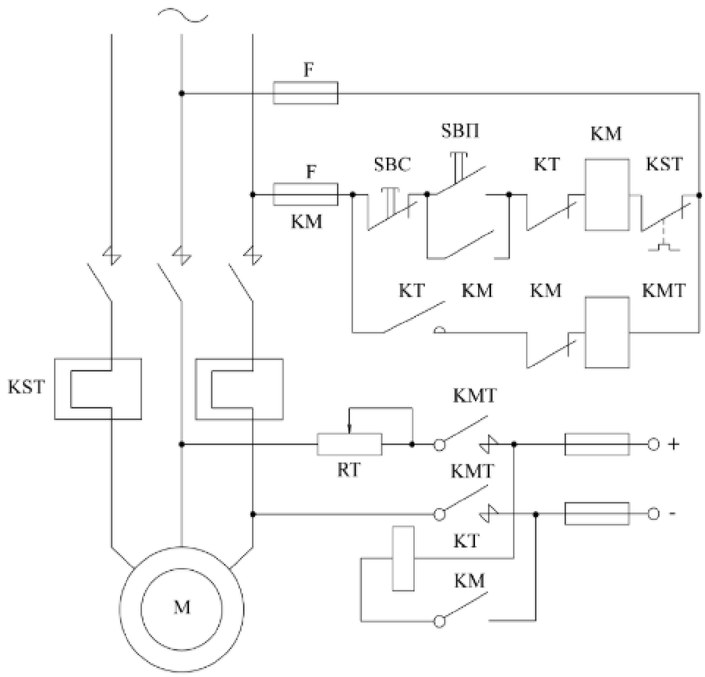


Figure 1. Dynamic breaking circuit of induction motor

В программном пакете Matlab + Simulink была разработана обобщенная модель ЧУЭП [9] для:

— учета пульсирующих моментов;

— оценки влияния сил трения на формирование скорости АД;

— выявления особенностей управления движением ИМ в зоне позиционирования (рис. 3).

In the Simulink package of the Matlab program, an immitative model was developed to obtain the following (Figure 2):

— stator current;

— rotor speed;

— elektromagnitic torque.

Model contains following blocks:

Asynchronous machine — squirrel cage induction motor (AD);

AC Voltage Source — AC voltage for supplying AD;

Switch — commutator;

DC Voltage Source —DC voltage source for dynamic breaking;

Current sensor — block to measure stator current;

Voltage sensor — block to measure stator voltage;

Rotor speed — rotor speed, rpm [3].

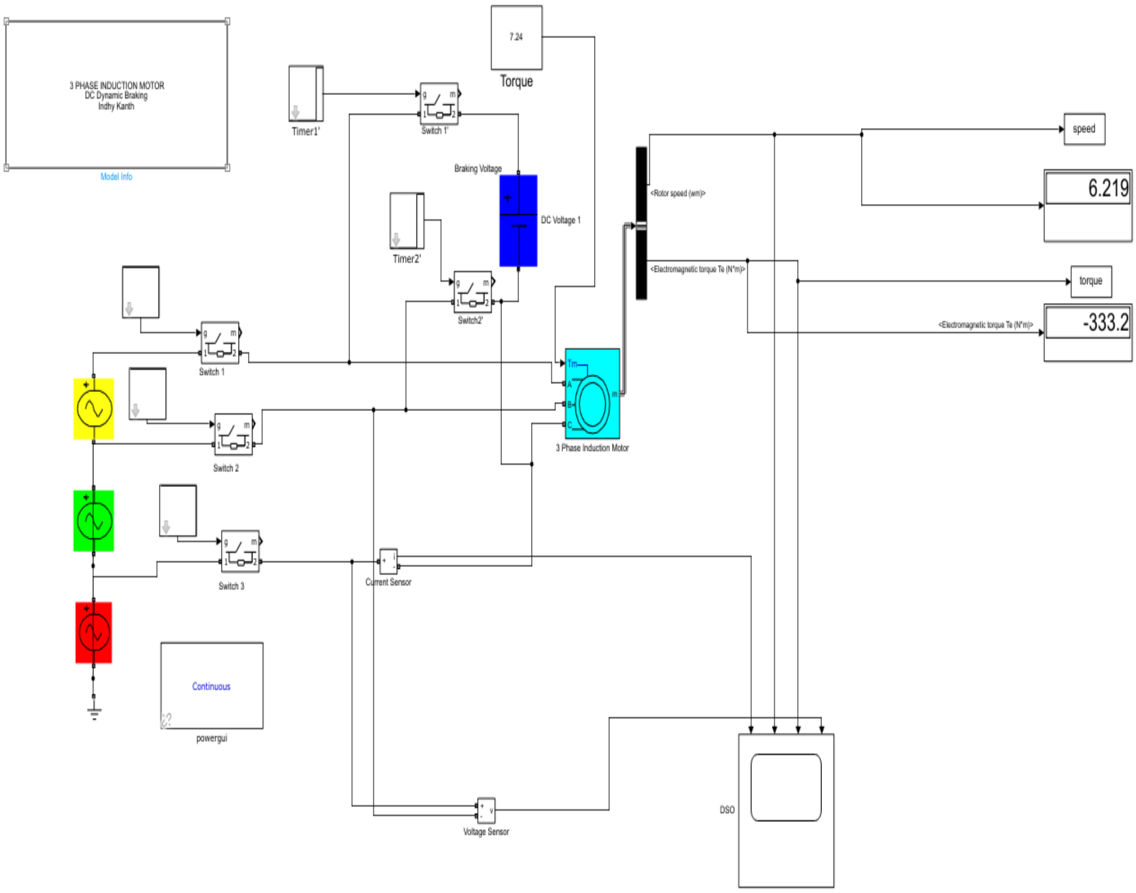
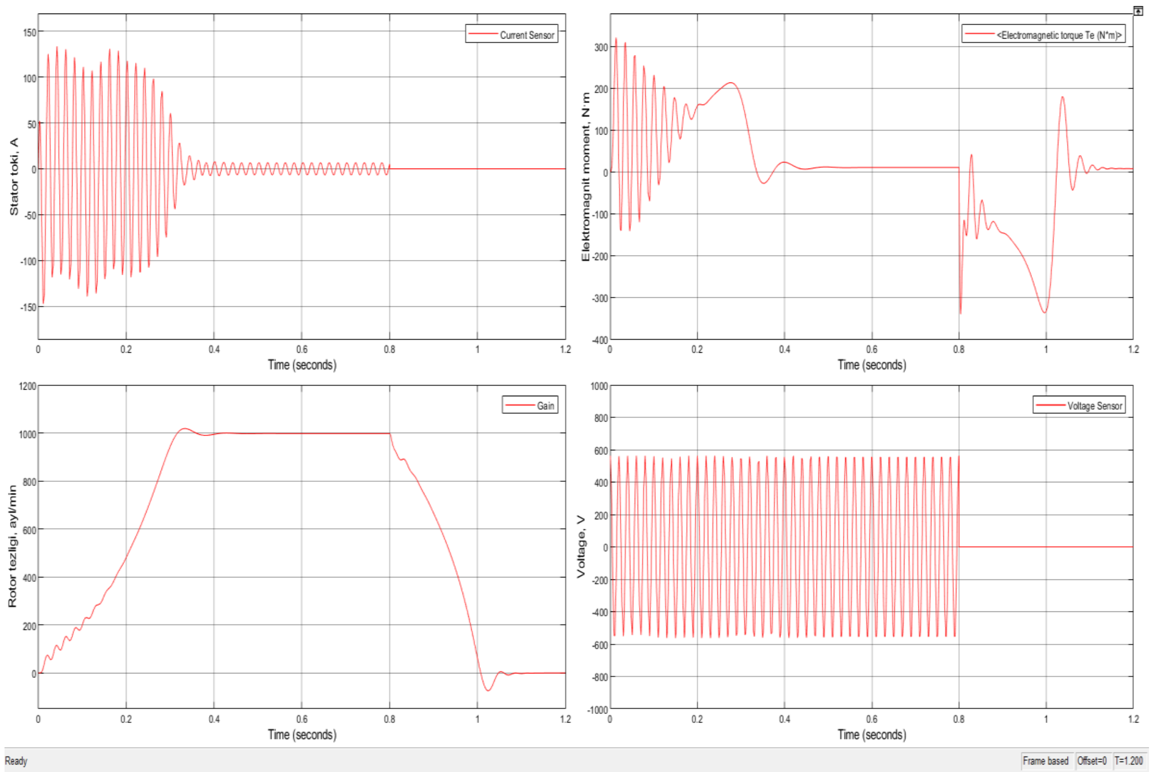


Figure 2. Dynamic breaking model of induction motor



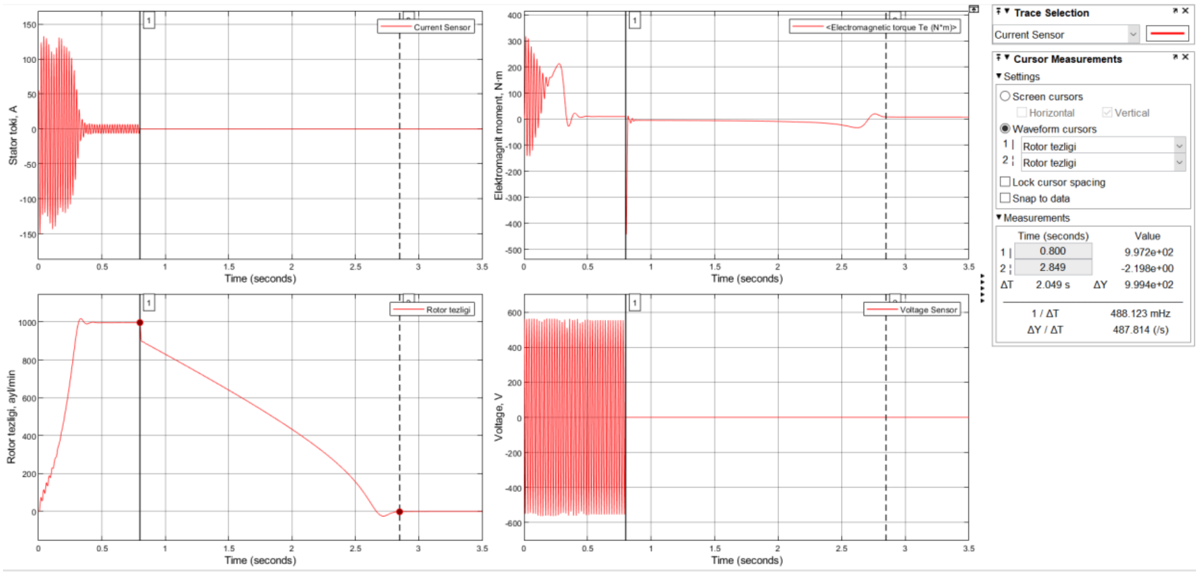


Figure 3. Change of induction motor parametres during dynamic: a) stator current, b) electromagnetic torque, c) rotor speed, d) stator voltage

The parameters of the motor in dynamic braking obtained through the model are presented in Figure 3.

Table 1. Main parameters of the induction motor

Parameter	Value	Unit
Nominal power	4.4	kW
Voltage	440	V
Frequency	50	Hz
Nominal speed	1000	rpm

When we change the braking current at different values, we can see that the braking times also change accordingly. The results obtained are shown in Table 2.

Table 2. DC voltage and breaking time

№	DC voltage, V	Breaking time, s
1.	100	0.3
2.	80	0.4
3.	60	0.57
4.	40	0.92
5.	30	1.325
6.	20	2.05
7.	10	3.2

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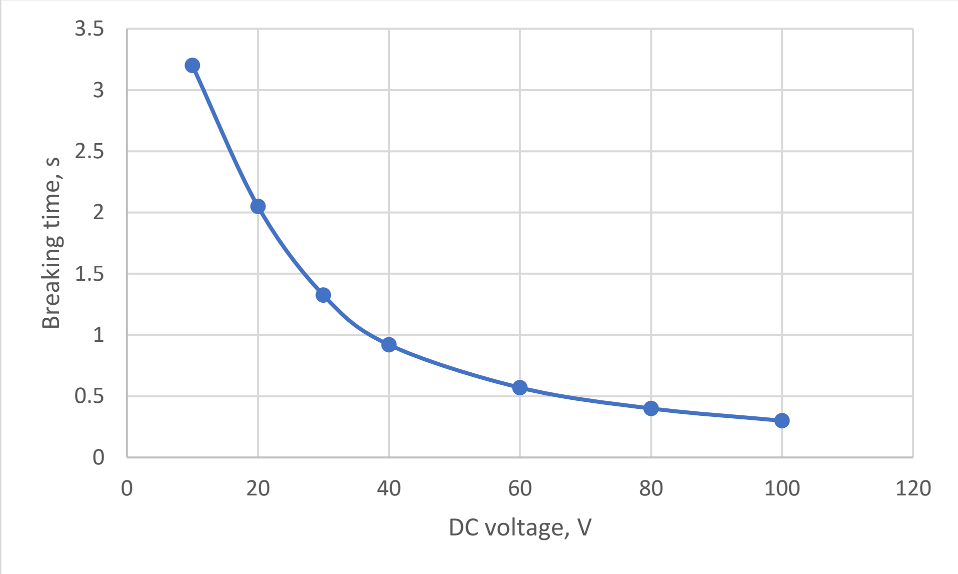

Figure 4. Dependence of braking time on braking current

CONCLUSION

When we construct a graph based on the data in Table 2, we can see that there is an exponential dependence between voltage and time. By the graph it is known that the more DC voltage is given to stator windings of induction motor, the faster it could be stopped, meaning that the braking time can be also adjusted.

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