TORQUE PULSATIONS MINIMIZATION AT STARTING OF A SMALL POWER INDUCTION MOTOR BY USING A PASIVE FILTER

Nicuşor TOTOR

Alcatel-Lucent University Timişoara , Romania

nicusor.totor@alcatel-lucent.ro

Abstract – **At starting of three phase IM or connection / reconnection in running , important torque variations are produced . Man can desire to diminish at maximum the existing peaks of instant torque by suppressing the low frequency harmonics from primary current spectrum .**

Keywords*: *current controlled inverter(CCI) , passive filters , torque pulsations attenuation .

1. INTRODUCTION

In [1] it is stated that the magnitude of torque pulsations , as a reaction to load variations are caused by interactions between low frequency components of primary currents (practically direct currents) with the fundamental components of secondary currents and inversely , the resulting torque is a synchronizing type and it is not desired from power conversion point of view . The filter's capacitor C_f mounted in series with the primary windings , will stop of the direct current, while the main alternating feeding current will pass trough ohm resistor of filter R_f mounted in parallel to C_f (see fig.1) . The value of resistance is designed to determine the needed current for steady state of IM

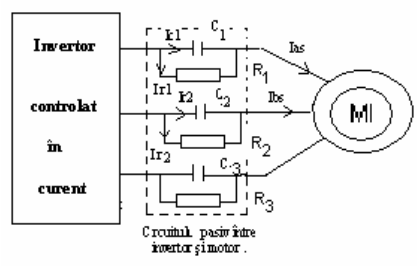

Fig.1 The considered system .

2. THE MODEL OF CCI + Filter + IM .

To analyze the transitory regime of IM we will use the primary electrical equations α-β, written in a stationary reference frame [2]. The mathematical model of the filter positioned between inverter and IM is chosen in matrix state form as :

$$\begin{bmatrix} \dot{X} \\ Y \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} X \\ U \end{bmatrix} \qquad (1)$$

with the following notation of the variables :

U- output variable i.e. the output voltage of inverter ,

X- state variable i.e. the equivalent electrical charge of capacitor ,

Y- input variable i.e. the primary current .

The dot sign is used to represent the differentiation in time of the state variable . Note that the output **Y** is not differentiated as usual in system theory . By inspection of fig. 1 the following relations are obtained :

$$\mathbf{a} = -\frac{1}{C_f} \qquad (2)$$

$$\mathbf{b} = -1 \qquad (3)$$

$$\mathbf{c} = \frac{1}{R_f} \qquad (4)$$

$$\mathbf{d} = 1 \; . \qquad (5)$$

All per unit parameters were supplied by the Manufacturer of the IM (Electromotor Timisoara) .

P_n = 0, 25 kW –*normal power* ,

I_n = 1,2 Aeff – *normal current* ,

n_s = 1500 rpm – synchronous speed ,

P = 2 – number of pole pairs ,

f = 50 Hz – normal frequency ,

cos φ = – power factor ,

s_n = 0,04 – normal slip ,

$\frac{M_k}{M_n}$ =2,2 – breakdown p.u. torque ,

$\frac{M_p}{M_n} = 2$ – starting p.u. torque ,

$\frac{I_p}{I_n} = 7$ – starting p.u. current .

C_f = 100 μF ,

R_f = 100 Ω .

3 . SIMULATION RESULTS .

To run the simulation an existing Simulink model of IM was used with insertion of the filter's subsystem as seen on fig . 2 [3] :

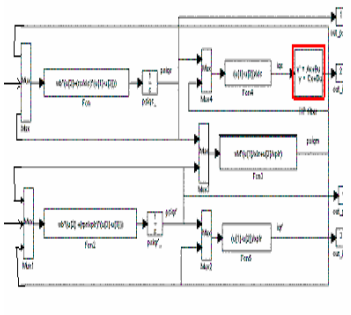

Fig . 2 Primary current calculus .

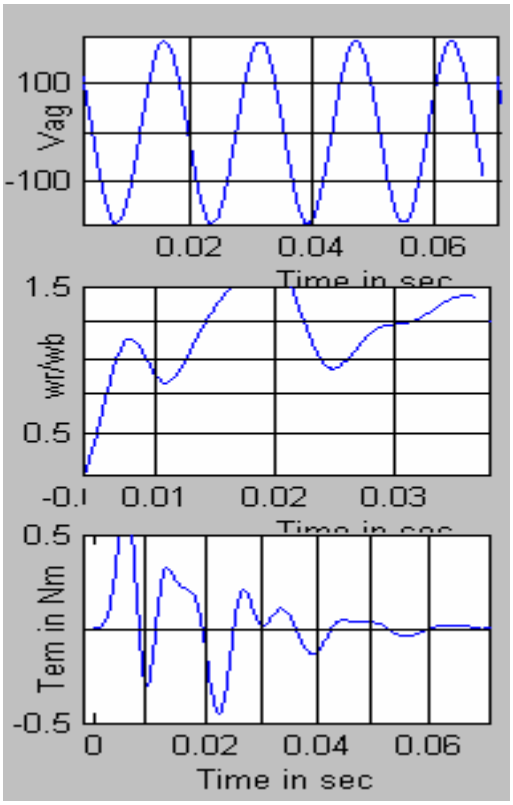

Fig . 3 . Voltage , speed , and torque at starting without filter .

In fig.3 it is shawn the voltage , speed and torque variations without the connected filter and in fig . 4 with the filter connected between inverter and IM , for comparison purposes . In fig.5 it is shawn the primary current, primary and secondary flux variations without the connected filter and in fig . 6 with the filter connected between inverter and IM , also for comparison purposes .

4. CONCLUSIONS

By comparison of fig.3 and fig.4 it can be seen the impact on starting torque pulsations at passive filter connection . This is a simple and cost effective practical procedure for minimization of torque pulsations .

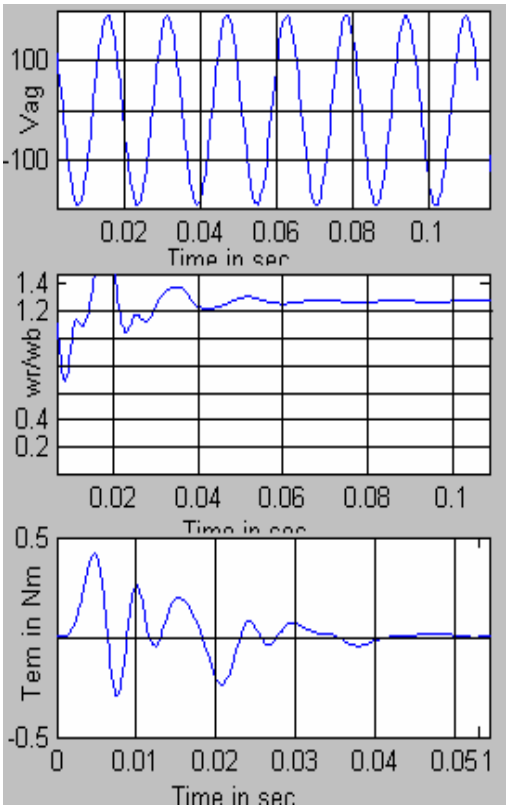

Fig . 4 . Voltage , speed , and torque at starting with filter .

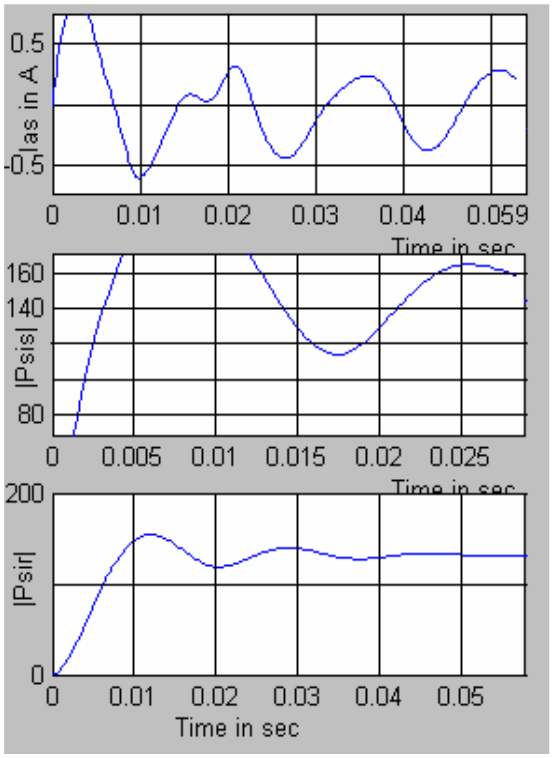

Fig . 5 Currrent and fluxes at starting without filter .

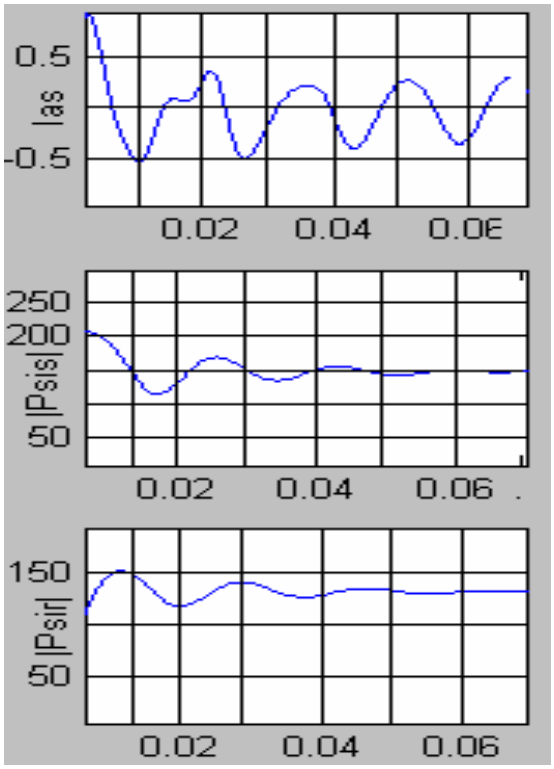

Fig . 6 Currrent and fluxes at starting with filter .

As power of IM increases as more efficient the method becomes , because of bigger magnitude of pulsations . As it can be seen the primary currents and voltages remains the same with or without the filter connected .

References

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