Figs. 14 and 15 give the obtained experimental results of the currents using the conventional DOL starting and the proposed starting method. A substantial reducing for the inrush current is noted comparing these obtained experimental results. Thus, the obtained results confirm the results obtained in simulations and. It also ensures the effectiveness of the method of reducing the inrush current. In conclusion, for the strategy proposed in this paper, the starting current and transient torque pulsations can be successfully reduced during the starting period.

IV. Conclusion

In this paper, a control method based on the soft-start technique is proposed to reduce the high inrush current and transient torque pulsations of a milling system consisting of a hammer mill driven by an induction motor. The proposed method is evaluated by simulations and validated in real-time by experimentation using a dSPACE control board. According to simulation results, the current reduction rate varies from 42% to 78%, depending on the applied starting time. The real-time experimental results show positive feedback on the proposed current limiting method's effectiveness and efficiency by corroborating the simulation results. Overall, the proposed method gives satisfactory results for inrush current limiting with good steady-state stability. However, the method presented is an open-loop control. The next step of this work is to use this method in closed-loop control. It allows to fix the rotation speed and to optimize the energy the efficiency of the grinding system.

Nomenclature

L_m	mutual inductance	H
L_r	rotor inductance	H
L_s	stator inductance	H
R_r	rotor resistance	Ω
R_s	stator resistance	Ω
ω_s	synchronous speed	$rad.s^{-1}$
ω	rotor angular speed	$rad.s^{-1}$
ω_m	mechanical speed	$rad.s^{-1}$
ϕ_r	rotor magnetic flux	Wb
ϕ_s	rotor magnetic flux	Wb
v_r	rotor voltage	V
v_s	stator voltage	V
i_r	rotor current	A
i_s	stator voltage	A
J	moment of inertia	$N.m.\ rad^{-1}.s^2$
f_r	friction coefficient	$N.m.s.rad^{-1}$
p	number of pole pairs.	
Q	cereals flow	$kg.min^{-1}$
α	cereals milling system parameter	$N.m.min^2kg^{-2}$
β	cereals milling system parameter	$N.m.min.kg^{-1}$
γ	cereals milling system parameter	N.m

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