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# Start-up and Reverse Analysis of Induction Motor Model in Pump Regime

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## I. Introduction

Nowadays pump drive systems are sometimes used as renewable energy sources. For example, produced energy from wind generator is supplied to pump. After that the pump transports water to reservoir that is located at high place. At the end the stored water is derived to hydro generator. In this case the cost of kilowatt per hour is lower. It means that this type of accumulated energy system will develop more in coming future [1].

## II. Induction Motor Model

Nowadays one of the most efficient transition processes under research can be achieved using mathematical analyses. Many authors pointed out that not always mathematical model includes all system elements and load variations. Therefore authors with the help of voltage and frequency control methods can make induction motor (IM) performances more efficient. Slip optimization reduces power loses, stator current and consumed power [2].

### *A. Mathematical Model in MATLAB Simulink*

Using program MATLAB Simulink a simple mathematical model was made. It consists of induction motor standard voltage equations and function of pump performance. The objective is to make function which can predict the efficiency of drive process.

### *B. Mathematical Model for Pump*

From Fig. 1 we can see that in several mathematical programs for pump accelerations process transitions use a squared function of torque-speed characteristic. But in real processes it can be otherwise.

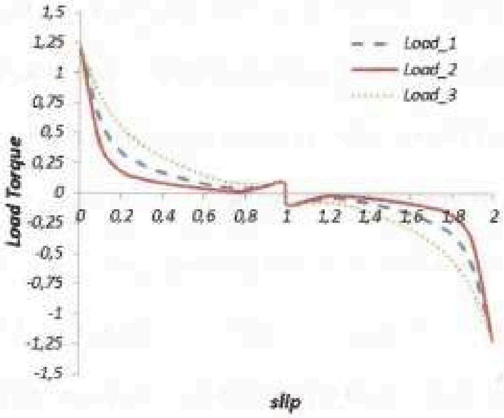


Fig. 1. Function of torque-speed characteristic for IM.

During IM research three kinds of pump characteristics there were chosen (Fig 3). As it is seen at starting moment load torque value is small but after acceleration it increased till nominal.

## III. Experimental Stand

For the research the induction motor test workbench from company LEROY SOMMER was used (Fig. 5). It consists of researched motor, parallel connected powder break, torque sensor (SCAIME), and speed transducer. IM rated data: Pn=0.3kW, Un=400V, In=1.33A, fn=50Hz, Tn=2Nm..

## IV. Results of Simulation

Reactive static load torque was chosen for IM model. It means, in motor mode reactive torque is opposing rotor motion. This process does not depend on rotor motive direction. Therefore, after stator windings are switched to contrary side it is required to change load torque value..

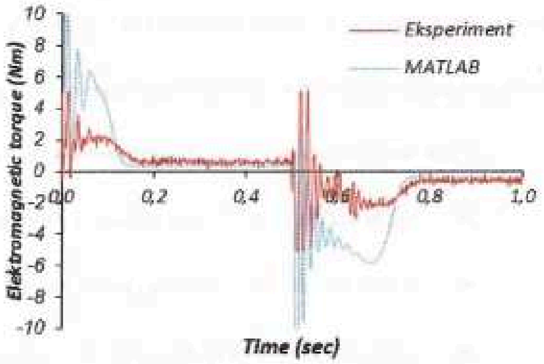


Fig. 2. Comparison between Electromagnetic torque in start-up and reverse transition process.

From Fig. 2 we concluded that in modeling IM transition process it is not necessary to take into account only constant load values. Start-up process can take longer time for acceleration if load torque remains constant. IM electromagnetic torque ripples in start-up process can be even 10 times more than nominal.

## V. Conclusion

Created IM mathematical model is very practical in treating the transients and control of symmetrical IMs fed from symmetrical voltage power grids or from PWM converters. In working process algorithm or in other words approximation for torque-slip characteristics was developed. Summing up this developed function can be used to describe ventilator and pump transition processes and to get more accurate simulation results as well.

## References

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