THE SPEED CONTROL OF THE INDUCTION MOTORS BY THE CHANGE OF SUPPLY VOLTAGE

Ing. Jiří Gärtner, Ing. Zdeněk Halámka - Authors

Department of Electric Drives and Traction, Faculty of Electrical Engineering,
Czech Technical University in Prague,
Technická 2, 166 27, Prague 6, Czech Republic
Phone: +420 2 2435 2812, 2136, Fax: +420 2 3333 9972, Email: Gartnej@fel.cvut.cz, Halamkz@fel.cvut.cz

INTRODUCTION

The main point of this topic is a speed control method of induction motors by a change of the supply voltage, but the frequency of supply voltage is constant. In fact this control method is a regulation by the slip, but this is caused by change of the voltage. This method is not useful for all applications. Because of this, the conditions of motor's stability are determined precisely.

BODY OF PAPER

The basic principle of this control method is really simple. But it is not possible to use this method everywhere. For this reason we suppose that the load torque has the parabolic shape. The slip of the IM increase with decrease of the voltage. Thus, we have to use the motor with the greater power than is the nominal power. For this reason, this control method is suitable for small paper range applications such as the ventilators, fans in air-conditions devices and so on.

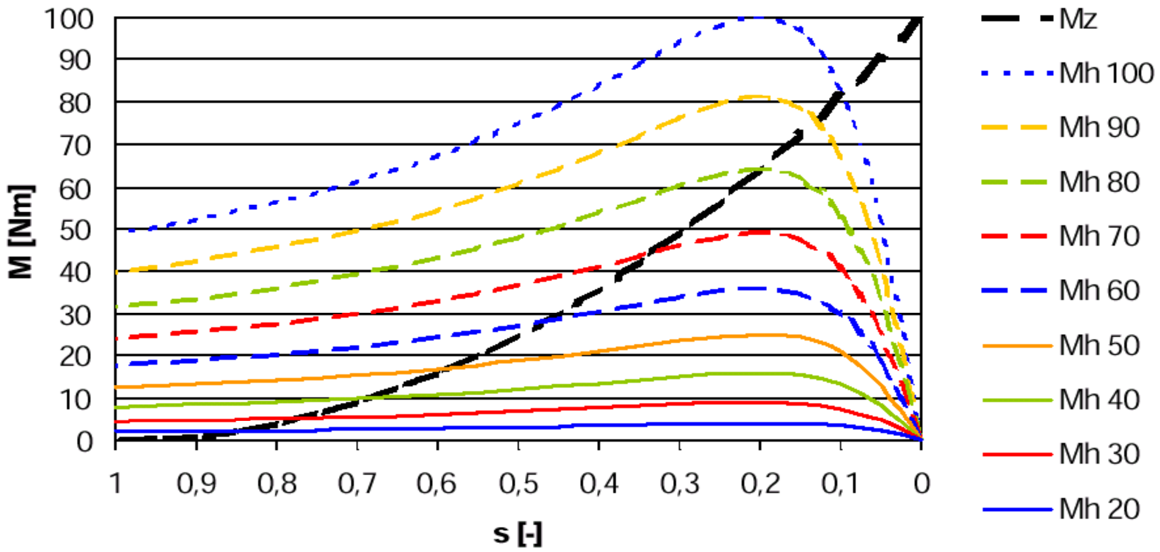

Fig 1. Torque characteristics of IMs - variable stator voltage and quadratic load characteristic. Intersection point means constant sinning of the shaft. (Mh 20 - number is a ratio of the stator voltage and nominal voltage)

For the description of stability is needed to known the shape of drive and braking torque. It is possible to describe the torque of IM by Kloos equation. But the deviation between the real values and the computed values is too high. Because of this, we decided to derive new version of the Kloos equation. With respect to its resistance the "Kloss-form" would be very complicated and it would describe only one IM. That is why we decided to form empirical description of the rotor resistance as a function of a dc stator resistance and of the other experimental variable. An experimental variable respects different types of the rotor. It assumes that stator resistance is equal to the rotor resistance. The better Kloos equation modified by empirical formula is below.

$$\frac{M_i}{M_{i\max}} = \frac{2*\left(1+s_{zv}*e^{A*s}\right)}{\frac{s}{s_{zv}}+\frac{s_{zv}}{s}+2*s_{zv}*e^{A*s}} \qquad \textbf{(1)}$$

The basic equation for steady state obtains we, when we compare the driving and braking torque. Drive will be in stabile state when the no-equation (2) reads.

$$\left(\frac{\partial M_h}{\partial \omega}\right)_{\omega_0} < \left(\frac{\partial M_b}{\partial \omega}\right)_{\omega_0} \qquad \text{or with slip} \qquad \left(\frac{\partial M_h}{\partial s}\right)_{s_0} > \left(\frac{\partial M_b}{\partial s}\right)_{s_0} \qquad \textbf{(2)}$$

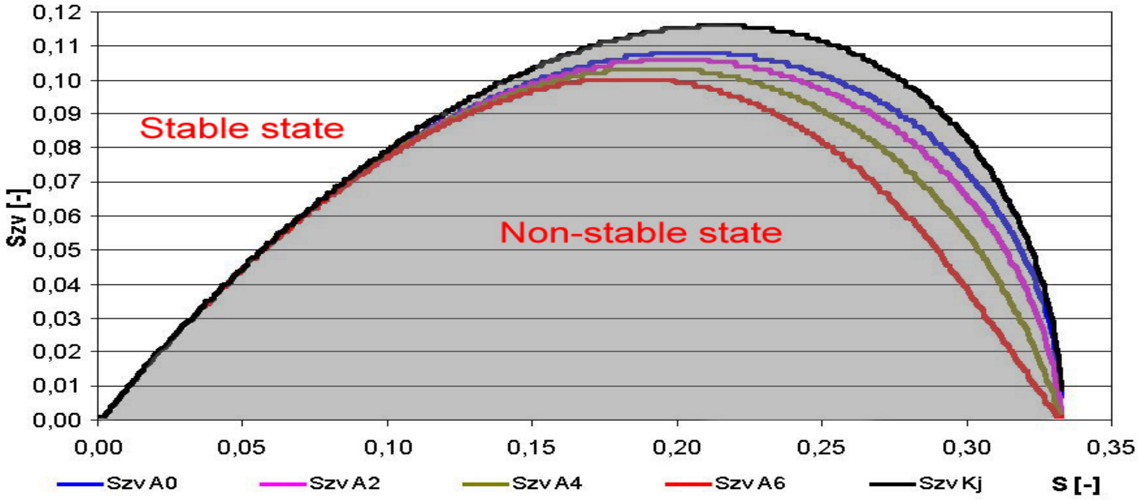

Fig. 2. - Range of unstable drive, it is function of slip and pull-out slip

CONCLUSION

From experiments and calculations we can say that is possible to change the speed of IM with quadratic torque characteristic within whole range. The unstable zone is only for machines with the pull-out torque smaller than 10.6%. Little machines have this slip about 15-20%. That is why it is possible to change the speed within whole range. But this kind of control has many disadvantages. The efficiency has quadratic decrease with speed, the current is greater then nominal one. The self-cooling at low speeds is very bad and machine is overheated. The big advantage is the use of power converter, for example AC/AC thyristor converter. This kind of regulation is used in laboratories, but the forced cooling is requested.

ACKNOWLEDGMENT

This research was supervised by Prof. Ing. Jiří Pavelka DrSc., Department of Electric Drives and Traction, Faculty of Electrical Engineering, CTU in Prague

REFERENCES

[1] Gärtner, J. - Halámka, Z.
Regulace rychlosti asynchronního motoru změnou napětí. [Výzkumná zpráva]. Praha : ČVUT FEL, Katedra elektrických pohonů a trakce, 2000. VZ156/K314/2000.