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Slip Control by Identifying the Magnetic Field of the Elements of an Asynchronous Motor

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CONTENT

Introduction

- Traditional frequency converters, also referred to as *V/f* (voltage/frequency), have the advantage in controlling the slip of an asynchronous motor that such an implementation is not costly and simple in terms of construction.
- The issue of asynchronous motor slip is devoted to a number of articles and research in the field of measurement and calculation of asynchronous motor slip, effective control of motor slip curve and optimization of motor slip curve with respect to its best efficiency or fault diagnosis and limitation of motor failures based on motor slip control .

Asynchronous Motor with Frequency Converter

- The frequency converter is characterized by fixed parts and generates a rotating magnetic field on the motor stator.
- If the rotor speed of the asynchronous motor differs from the speed of the stator magnetic field, a slip occurs between these fields. The method of motor control is based on the slip change. It is actually a necessary condition for the generation of mechanical energy, which is essentially a condition for asynchronous motors to start.
- However, the disadvantage is the dependence of the motor losses on the slip. Here, if we want to achieve small motor losses, the slip must be minimal (usually from 2% to 6% of full load).

Motor Slip Measurement

- The measurement was performed on an asynchronous motor with a frequency converter and a power of up to 160 kW.
- Fig. 1 schematically shows the individual elements of the fan of an asynchronous motor, where A is the motor shaft, B is the motor, C is the Propeller and D1 and D2 are bearings.

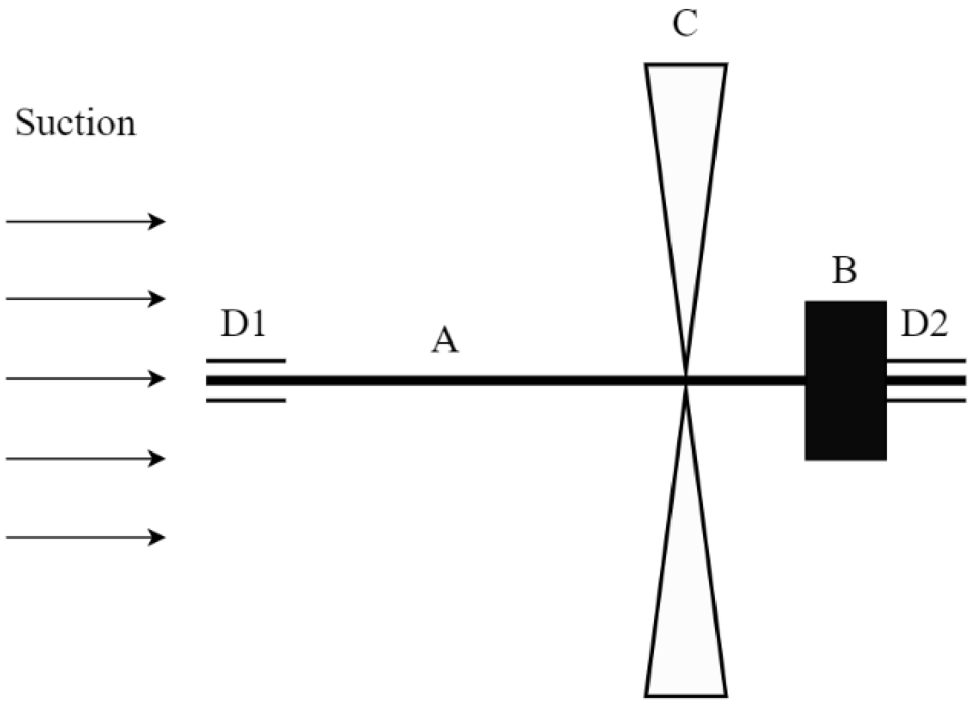

Fig. 1. Schematic representation of the motor

Motor Slip Measurement

- The VEMA-041 magnetometer was used as an element of magnetic field identification, which allows to measure three selected components of the magnetic induction vector simultaneously.
- The measuring point was 1.5 meters away from the shaft axis of the asynchronous motor, as the fan with the asynchronous motor was located in the air duct.
- Fig. 2. shows the amplitude spectrum of the magnetic induction Bz for Z direction.

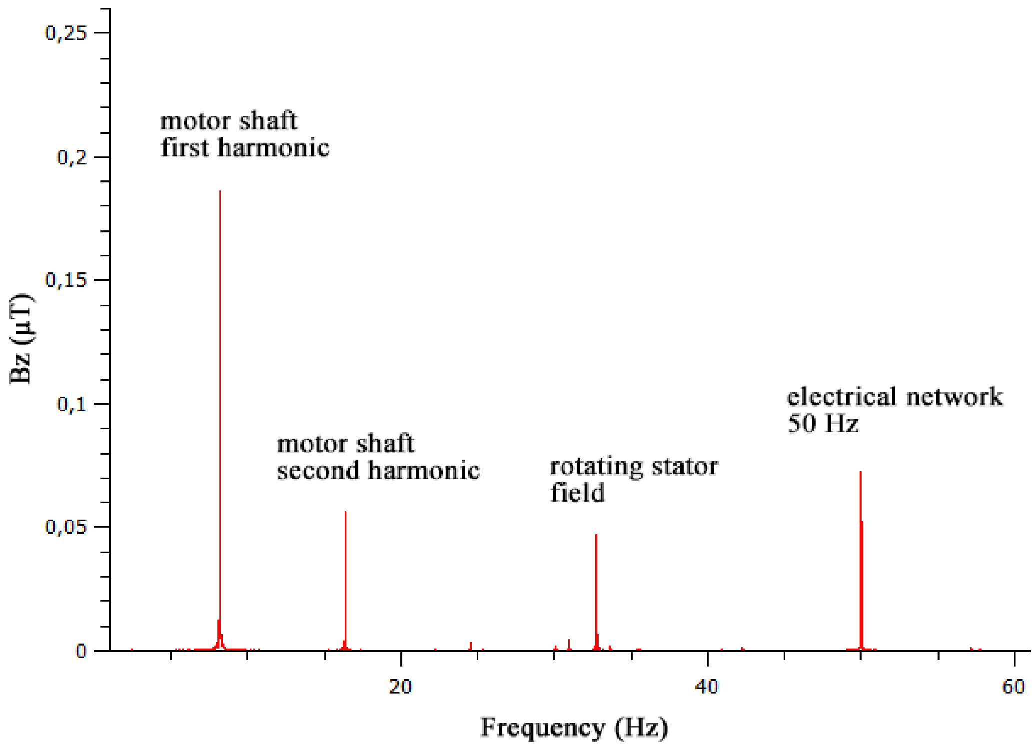

Fig. 2. Amplitude spectrum Bz, in the direction of the Z axis.

Motor Slip Measurement

- The first harmonic frequency of the rotor was found to be at a frequency of 8.1697 Hz, double of this frequency, thus the second harmonic frequency was at 16.3394 Hz.
- The stator excitation frequency (referred to in the graph as the rotating stator field) was 34.7449 Hz at four dipoles.
- It is therefore 8.6862 Hz for one dipole of an asynchronous motor.

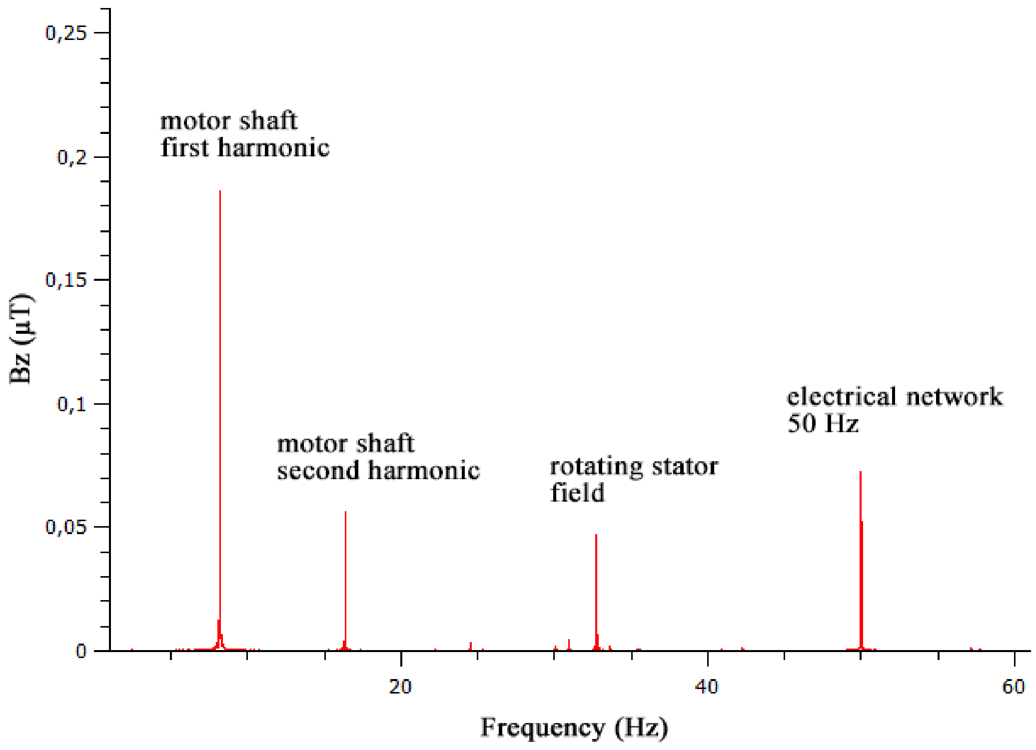

Fig. 2. Amplitude spectrum Bz, in the direction of the Z axis.

Motor Slip Measurement

- The slip of the rotor field behind the stator field is given by the ratio of the frequency of the magnetic field on the stator and the magnetic field of the rotor of the asynchronous motor at a specific time.
- The frequency of 8.6862 Hz corresponds to a rotation value of 521 rpm and a frequency 8.1697 Hz corresponds to a rotation value of 490 rpm, which corresponds to a slip level of 5.9%.

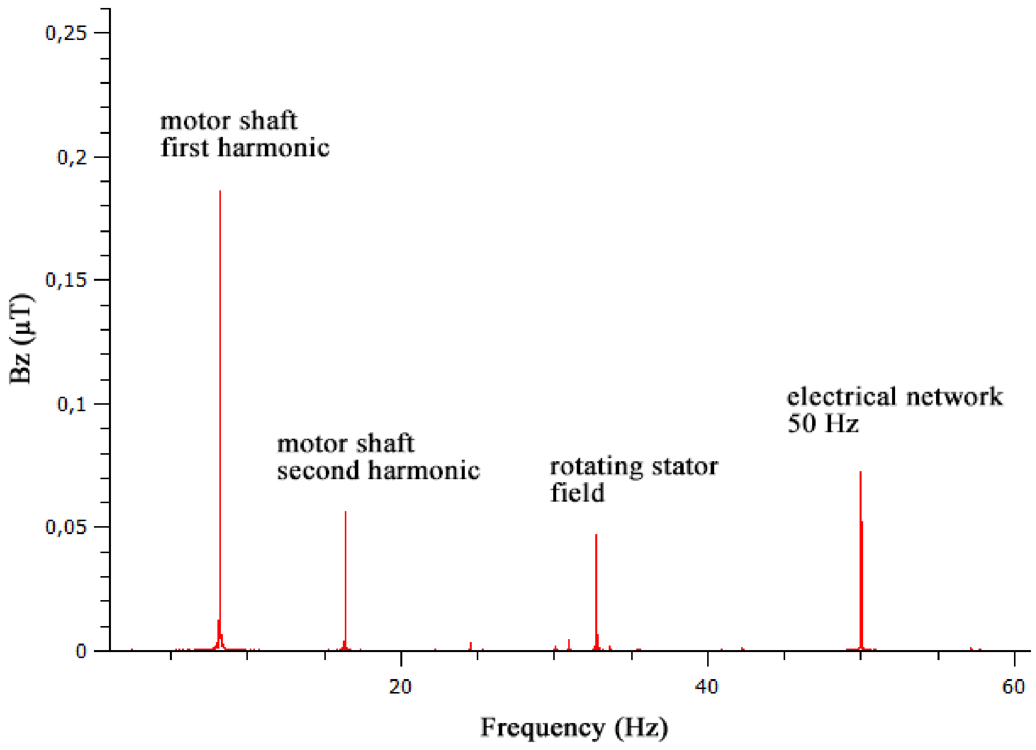

Fig. 2. Amplitude spectrum Bz, in the direction of the Z axis.

Motor Slip Control

- The principle of the technical solution is to measure the magnetic field of the elements of an asynchronous motor, which means measuring the frequency of magnetic induction of the stator of an asynchronous motor and the frequency of magnetic induction of a rotor of an asynchronous motor.
- By comparing these frequencies, it is possible to have information about the actual slip. These magnetic induction frequency values are used to control the input parameters of the frequency converter.

Motor Slip Control

- The block diagram of slip control is shown in Fig. 3, where *fs* is the frequency of magnetic induction of the stator of an asynchronous motor and *fr* is the frequency of magnetic induction of a rotor of an asynchronous motor.

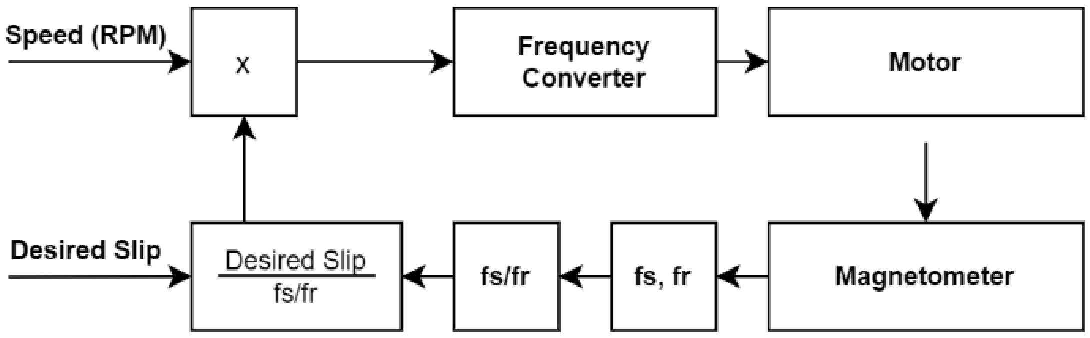

Fig. 3. Block diagram of slip control.

- The advantage of this solution may be that by one measurement of the magnetic induction of the asynchronous motor elements, it is possible to identify the actual frequencies of the rotating elements of the asynchronous motor and the stator excitation in order to control the slip. Another advantage is the non-contact measurement.

CONCLUSION

- Based on the results of the measurements, it was shown that it is possible to determine the first and second rotational frequencies of the rotor and the excitation frequency of the stator by means of a triaxial magnetometer.
- By the ratio of the frequency of the magnetic field on the stator and the magnetic field on the rotor, it is possible to detect the slip of the rotor field behind the stator field at a given moment.
- The article also described the method of measuring the slip using a three-axis magnetometer of an asynchronous motor and its subsequent control by setting the input parameters of the frequency converter.
- The scientific contribution of this work is in the description of a new methodology for measuring and controlling the slip by identifying the magnetic field of the elements of an asynchronous motor.

THANK YOU FOR YOUR ATTENTION

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