Research of Alternating Current Single-Phase Collector Motor Models Developed on the Basis of Project Design Data

Bohdan Kopchak
ECS Department
Lviv Polytechnic National University
Lviv, Ukraine
kopchakb@gmail.com

Marianna Kopchak
FL Department
Ivan Franko National University of L'viv
Lviv, Ukraine
mariannekopchak@gmail.com

Andrii Kushnir
OPAFA Department
Lviv State University of Life Safety
Lviv, Ukraine
andpetkushnir@gmail.com

***Abstract*—The model of an alternating current single-phase collector motor in the MATLAB Simulink environment has been developed and researched on the basis of the data obtained through project design calculation, during which all the motor parameters required for the mathematical model have been obtained. It has offered considerable opportunities for applying this approach in further research of this motor type. The model of such motor has been also developed and investigated on the basis of an existing universal motor model in the library of MATLAB Simulink and the data obtained from project design calculation. A comparative analysis of the results obtained on both models has allowed for the conclusion about high degree of their coincidence and the possibility of their application for further studies.**

Keywords—single-phase collector motor, alternating current, mathematical model, project design calculation

I. INTRODUCTION

Recent developments in the field of synthesis and modelling of both electromechanical systems and microelectromechanical systems have shown an increased interest in the research of alternating current (AC) single-phase collector motors (SPCMs) as a sub-type of universal motors. However, unlike universal motors, the AC SPCMs are not designed to work from a DC network. AC SPCMs are the motors similar in design to series-excited DC motors, but are powered by an AC network. Such motors develop significant rotating torque, are relatively small-sized and lightweight, and also provide high rotation speeds which can reach the mark of several tens of thousands of rpm.

Recent evidence suggests that AC SPCMs have been widely used due to the possibility of obtaining different rotation speeds that can be easily, smoothly and economically altered in a wide range, as well as because of relatively high efficiency output, good starting torque under small starting currents, and relatively low cost.

The above-mentioned can be exemplified by the fact that home appliances and manual power tools run on AC SPCMs with rotation speeds ranging from 5,000 to 30,000 rpm and powered by networks with 50-60 Hz industrial frequencies and the standard 220 V voltage. Various examples of using such motors with power ranging from a mere fraction of a watt to several kilowatts have been discussed in [1].

However, the analysis of previous studies has indicated that far too little attention of the researchers has been paid to the problem of modelling the operation modes of this motor type, mainly due to the absence of their parameters. Some data, such as nominal voltage, power, and speed in particular, can be obtained from the nameplate data, which is definitely insufficient. The development of a mathematical model for a universal motor has been considered in [2], but the researchers have only dealt with approximate parameters. AC SPCM, powered by the inverter, has been investigated in [3]. This type of AC SPCM is factory-made and its major but not all parameters are known from the nameplate data.

In the latest versions of MATLAB Simulink package, a universal motor model has appeared [4] that can be used to investigate the AC SPCM, However, it is not clear enough from the description what mathematical model has been used there, and its parameters refer to the American standard of supply voltage.

The main objective of this research is to develop and investigate the AC SPCM model in MATLAB Simulink environment on the basis of the data obtained through project design calculation. The research aims to develop a different AC SPCM model based on the existing model of a universal motor from the MATLAB Simulink library and investigate whether it can be used for the study of AC SPCMs. This paper also intends to compare the results obtained on both models and draw conclusions about the coincidence of the results obtained and the prospects for further application of such models.

The result of the research provides for the development of recommendations regarding the possibility of applying the following approach to the creation of AC SPCM models on the basis of project design calculation data and their simulation in a particular program.