MONITORING THE OPERATING PARAMETERS OF AN ELECTRIC MOTOR

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Rezumat. *Automatizarea are scopul de a creşte productivitatea şi de a satisface toate cerinţele şi nevoile clienţilor. Această modalitate de dezvoltare intervine în momentul în care compania a ajuns la un nivel în care este necesară creşterea productivităţii pentru a satisface nevoile clienţilor. Automatizările industriale au rolul de a oferi productivitate maximă, de a uşura şi de a mări volumul de muncă depus de operatorii unami într-un proces de producţie de bunuri, putând, de asemenea, eficientiza furnizarea de servicii. Din această cauză se pune accent pe automatizările industriale, pe calitate, pe eficienţă şi pe tehnologie informaţională.*

Abstract. *Automation aims to increase productivity and to meet all the requirements and needs of customers. This kind of development occurs when the company reached a level where it is necessary to increase productivity in order to meet customers' needs. Industrial automation is designed to provide maximum productivity, to ease and to decrease workload of human operators in a process of production of goods, which can also provide efficient services. That is why it is important to lay stress on industrial automation, quality, efficiency and information technology.*

Keywords: *Integrated automation, PLC, electric motor, monitoring.*

1. Introduction

Industrial automation includes a range of equipment and processes designed to render all production lines more efficient. In other words, what was done in the past by human operators, now it can be done easily by automated equipment. Offering a clear advantage, automation has gained ground in almost all sub-branches of industry and not only. Industrial automation is seen and considered as a necessity for the existence, survival and development of any company which has a high productivity [1]. Representing a vast field, automation is a complex branch of technique, without which the large and small producers cannot continue to work.

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The advantages of automation are the following:
- Increasing the flow or productivity;
- Increasing quality and increasing the predictability of quality;
- Increasing product robustness and consistency;
- Lowering costs per product unit [2].

Below we'll mention some of the main disadvantages of automation:
- Vulnerabilities related to security and proper functioning of the programmes that operate the machinery;
- Initial costs are high: a product automation, workflow, or even the entire production line requires a large investment power from the company that wants radical changes in the field of automation;
- Development costs are high and difficult to predict. These are generated by changing technology, work processes, etc. [3].

The main objective of this paper is to develop new solutions for the automation of an integrated system and a study of the active control of the parameters of the drive which belongs to a machine tool. Keeping the performance of the electric motor within the allowable limits imposed by standards and thus reducing the failure rate can be is achieved by protecting and not by overloading the motor. Safety mechanisms are important for any type of equipment. This type of measure is necessary in order to prevent any damage which may cause time and financial losses. Siemens Starter software helps to connect the rectifier to a PC, and the engine sensors can measure, by capture, various parameters such as: speed, torque, voltage, amperage, frequency and power consumption.

2. Structure of the Automation Solution

Due to the high memory capacity of the autonomous console, off-line programming solution typically uses complex programming software which has multiple programming possibilities due to a complex graphic user interface. Simulation facilitates the possibility of testing the created program. One such programme is a software from Siemens called TIA Portal.

Fig. 1. TIA Portal software (Siemens).

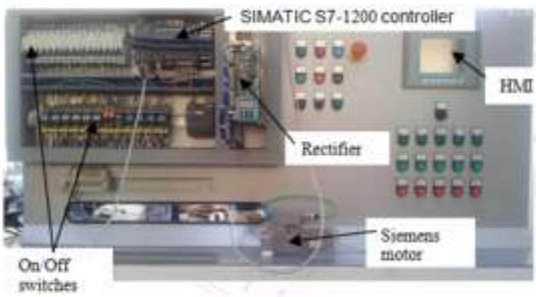

Fig. 2. Automation stand (Siemens).

This is complex programming software which tests and simulates different variants of PLC connections. By contrast, on-line version uses minimal software, with reduced programming, usually limited to the introduction of words in a command line environment, without having a graphic user interface [4].

The system includes a Siemens motor 1FK7022-5AK21-1DG0. The motor has 6000 RPM, 1.8 kg, 0.37 kW rating power and an input voltage of 230 V. A programme will be created in TIA Portal in order to create a safety measure for a drilling machine. The research will be made on the equipment presented in Fig. 2.

2.1 Components of the stand

In order to have a valid example that can be compared to new and advanced systems, a Siemens automation was chosen. The stand that was used for this study contains the latest models of automation components that have the best available firmware in order to function at the maximum potential. The SIMATIC S7-1200 (Fig. 3a) compact controller is the modular, space-saving controller for small automation systems that require either simple or advanced functionality for logic, HMI and networking. The SIMATIC S7-1200 controller panels can be programmed with the TIA Portal engineering software. The ability of programming both devices using the same engineering software significantly reduces development costs. The TIA Portal includes STEP7 for S7-1200 programming and WinCC for designing Basic panel projects. S7-1200 can be extended up to 11 modules and uses PROFINET or PROFIBUS communication protocols that are specific protocols used in the automation industry because smaller information packets are transmitted with a higher speed. These protocols have a lower response time than the TCP / IP protocol. It contains a card that loads the programme to be run and it is a compact product containing a CPU and more inputs and outputs, which are analogue or digital. On the left side of S7-1200 communication modules are available and on the right are signalling modules (inputs / outputs).
SINAMICS S120 (Fig. 3b) is a modular drive system with servo and Vector Control. The SINAMICS S120 AC Drives especially supplement the DC/AC units with a central power in feed and a DC link in types Booksize and Chassis for multi-axis applications.

1FK7 (Fig. 3c) motors are permanent magnet excited synchronous motors. The self-cooled motors are characterized by superior overload capability, ruggedness and compactness. The connection via rotatable connectors and preassembled cables ensures a flexible, fast and safe connection to the converter.

Fig 3. Components of the stand.

a. SIMATIC S7-1200 controller. **b.** SINAMICS S120 Rectifier. **c.** Electric motor 1FK7022

2.2 Connecting the automated system

The TIA Portal is a software solution which optimizes all planning, machine and process procedures. With its intuitive user-interface, simple functions, and complete data transparency, it can connect all kinds of equipment.

Pre-existing data and projects can be integrated or updated depending on the user's needs. This software is used to connect all the equipment through the special automation Ethernet protocol that is called Profinet.

The motor is equipped with a filter in order to filter the positive harmonic from the electric network. The connection between the actuator and the converter is realized by DriveCliq (the green cable) and the converter is connected to the PLC through an Ethernet cable. [5]

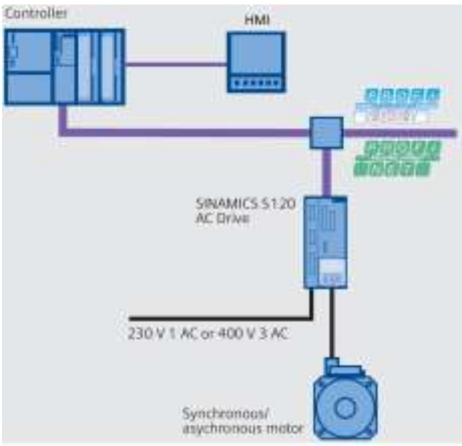

Fig. 4. The principle of connection of the Siemens automatic system.

3. Siemens Starter

The Siemens STARTER software helps for parameterization, commissioning, troubleshooting and, when needed, service or maintenance. This software import data from the rectifier and provides the opportunity to realize a quicker process parameterization, avoiding possible invalid entries and thus reducing production costs [6]. Setpoint and actual values can be tracked in real time. Starter also offers a graphical user interface for configuration [7]. This provides a better overview and a simpler handling. Once a program is created, in order to make it more efficient, some parameters from the rectifier can be modified using Starter software. The Siemens Starter recognizes the rectifier's type through the Ethernet cable and a virtual model can be downloaded on the PC, already having initial settings on the drive. Default settings can be saved as a project and they can be modified in offline mode.

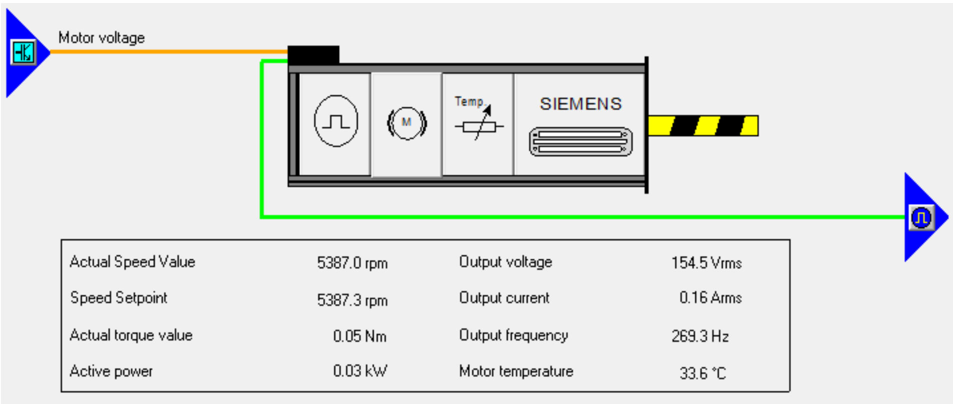

Fig. 5. Graphic display of the motor, where you can observe while operating values of speed, torque, power consumption, frequency and temperature.

In the "motor" menu, more engine parameters in real time can be followed, such as values of speed, torque, power consumption, frequency and engine temperature. There is little difference between the set speed and the actual speed of the motor. Through its settings, the rectifier is trying to keep the engine speed as close as possible to the set.

3.1 Data acquisition

The Siemens Starter has a data acquisition module which is found in the menu "Commissioning" -> "Device trace". Within the data acquisition module, the user can choose many parameters that can be recorded. For the present research, was chosen as data acquisition to be done for speed and torque for a period of ten seconds.

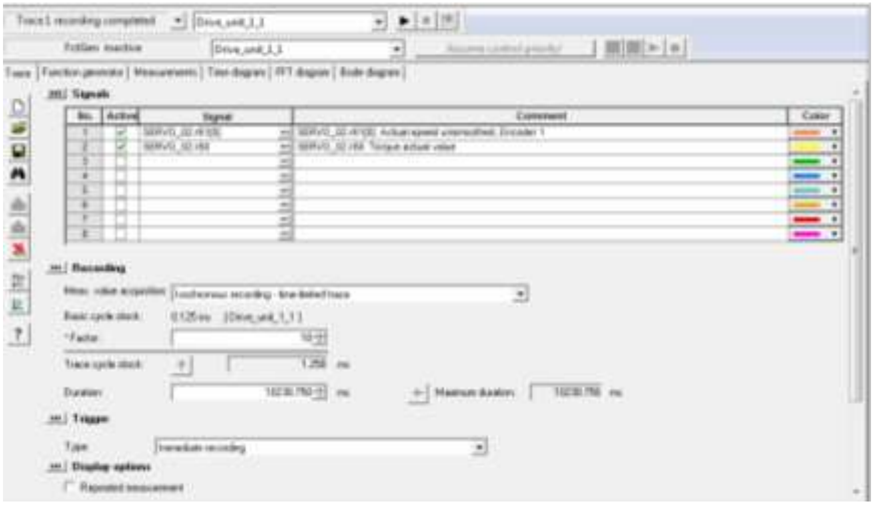

Fig. 6. The menu where the parameters are chosen in order to be followed during the acquisition.

Two cases were chosen for the acquisition. In the first case two limits were imposed: speed to 4000 rpm, torque to 0.1 Nm. Also the engine's start up time was changed from one second to ten seconds. During the start up, the engine can't pass the maximum speed or torque limit set by the programme. In the second case the speed was limited to 4000 rpm, the torque to 0.04 Nm and the motor start up time was changed from one to ten seconds. Due to the torque limitation, the speed of 4000 rpm wasn't reached. The values were measured every 10 ms and exported to the MathLab to create other graphs.

3.2 Case I

In the first case the speed was limited to 4000 rpm and torque to 0.1 Nm. The engine start up time was changed from one second to 10 seconds. As can be seen in the graphs below, the value of the torque increases considerably once with the decrease of the engine start up time. A visible difference is between the start up time of 1s and 3 s. For the start up time of 1s, torque values are recorded as they reach 0.09Nm, while for the start up time of 3 s, the maximum value that the torque reached was 0.07 Nm and after, the couple remains stable at 0.05-0.06 Nm. For a reduced stress and for greater engine durability, it is recommended that the start up time should be set between 3 and 10 seconds.

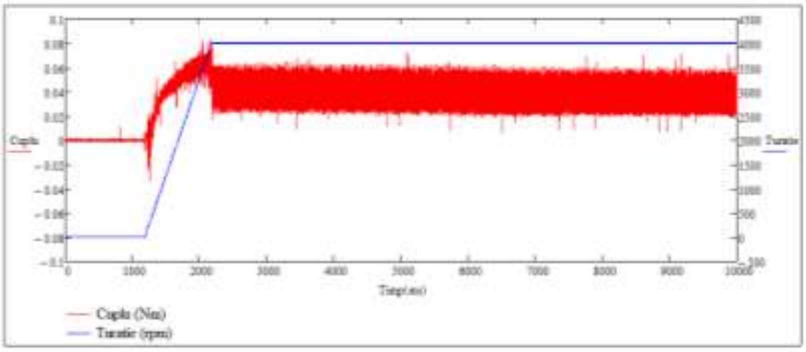

Fig. 7. Graph of torque and speed with the motor start up time of one second.

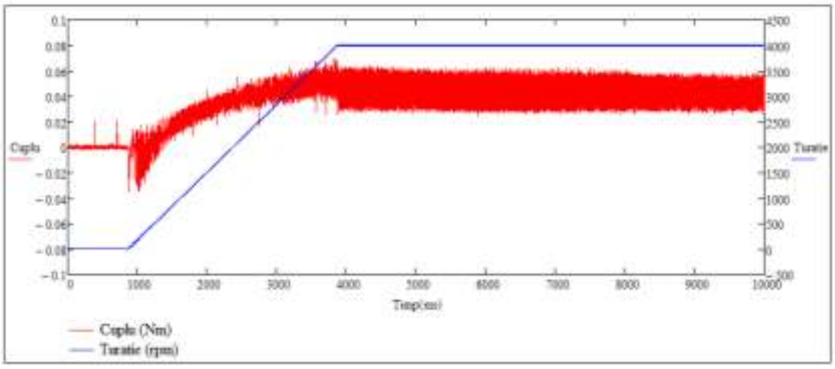

Fig. 8. Graph of torque and speed with the motor start up time of three seconds.

3.3 Case II

In the second case the speed was limited to 4000 rpm and the torque to 0.04 Nm and the engine start up time was changed from one second to 10. As it can be seen in the graph below, there was no significant change. Because of the torque limitation to 0.04 Nm, the engine speed range was between 2300 and 2500 rpm, and the maximum speed of 4000rpm was not reached.

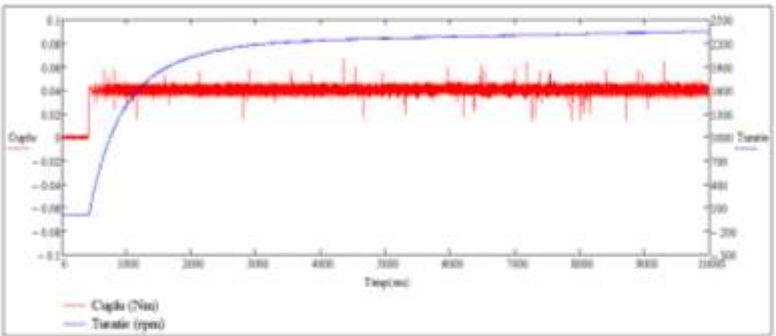

Fig. 9. Graph of torque and speed with the motor start up time of three seconds.

4. Conclusions and Future Work

In the first case was observed a considerable increase of torque for the measurements while the engine start up time was one or two seconds. Once the start up time exceeded 3 seconds, the couple values lowered, being less demanding for the engine. In the second case, even if the speed has been limited to 4000 rpm, it did not pass 2300 to 2500 RPM because the torque was limited to 0.04 Nm. Regardless of the engine start up time, it behaves in the same way and manages to maintain constant torque, being to the detriment of the speed. The prospects of this work are represented by an active control study of the parameters of a drive system that aims to produce an engine load. Using Starter a mathematical model will be created with which torque values can be changed depending on speed, voltage and amperage.

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R E F E R E N C E S

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