AC Drive Control System of the Wire Drawing Machine with DTC Control and Fuzzy Controller

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***Abstract*—One of the biggest challenges in wire drawing processes, is to keep the straining force of the wire almost constant of the allowed maximum. The paper presents a high performance variable speed AC drive with DTC control of an induction motor, using a Fuzzy controller for the winding mechanism of the wire drawing machine. The automatic system controls the straining force in the wire. PI and PI-Fuzzy control methods are applied to select higher performance one. The simulation results show that methods like PI-FLC are more efficient to decrease energy consumption and increase the performance of driving system. Using system modelling, it was proved that the proposed driving system has high efficiency and good stability of the working speed ranging 0–1200 m/min during acceleration and deceleration of the winding machine, without mechanical shocks that could cause the breaking of the processed wire.**

Keywords—winder, AC drive, force control, DTC, PI controller, fuzzy controller, modeling

I. INTRODUCTION

Drawing the wires faces several limitations in the mechanical designs along with the electrical noise and transients leading to too much disturbance which is highly unacceptable in industrial process control engineering. Furthermore, some of the essential controlled parameters like the wire thickness and the wire straining may unnecessarily show variations.

In this paper, the wire winding tension control system is the main object of research.

The main problems proposed to be solved in this paper are:

- the mathematical model of the control system identifying;
- straining force loop parameter set for winding mechanism with PI and Fuzzy controller;
- modelling of the DTC control system of winding mechanism with PI and Fuzzy controller.

The developed control system must meet the following requirements:

- quick start of the wiredrawing machine without shocks of straining force;
- constant straining force to exclude the breaking of the wire at high winding speeds.

The driving control systems typically have two working modes: motor speed control and torque control. The chosen control system of wire straining force must ensure the precise and constant force about 3-10% depending on the destination.

Winder and un-winder are drives with constantly changing load as they process and regulate wire tension. The changing spool diameter requires the control system to adapt continuously to the correct spindle speed, and effectively control the alterations in the spool mass, while providing accurate wire tension control performance. Typical internal components of a wind tension control system can include:

1) A diameter calculator;
2) A closed loop process controller (i.e. PID or fuzzy);
3) An inertia calculator.

Through these interconnected modules, the tension controller, drive speed, and current controller's set points and performance variables are established. These tension controller components and the process variables they produce are all directly dependent on the accuracy of the actual roll diameter.

The accuracy of the diameter calculator component is highly critical to the system's performance, to the point that it may be considered the most important element in the control system [2], [13].

Actual roll diameter can be measured with a sensor or calculated with input values of wire and spindle motion. Since measuring roll diameter is normally only suitable for the initial or starting setting, the running diameter is calculated repeatedly during the process. Multiple technologies exist for calculating the running diameter, but modes that use actual or derived position changes in the web and spindle can offer greater performance [3], [6].

II. MATHEMATICAL MODEL OF WINDING MECHANISM

A. Straining Force Adjusting

Straining force adjusting at winding can be achieved in two ways: by direct measurement of the force from wire or by modifying some parameters indirectly [2-3], [6].

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