

DEVELOPMENT OF A GENERIC TENSION CONTROL SYSTEM

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ABSTRACT

This paper describes the development of a Generic Tension Control System (GTCS) test bed that is to be used to train people and demonstrate the principles of tension control. In order to correctly size the motors, the associated power electronics and sensors required by the GTCS a system model has to be developed in order to assess the performance and requirements via simulation in SIMULINK. The simulation results are presented and it is shown how the system components were sized.

1. INTRODUCTION

In the rolling industries, such as the paper, steel, aluminium, etc, it is important to maintain the correct tension in the material to achieve both high product quality and production output. Most tension control systems employed in this country are imported and there is very little understanding of the underlying principles. DC drives are employed in most industrial rolling applications as they allow both torque and speed control that are essential to achieve tension control.

In all tension control applications the underlying principles are similar although the manner in which they manifest themselves in specific applications may differ quite markedly. In the steel rolling industry for example the material is changed in shape by rolling it in a manner in which the cross-sectional area is reduced. By the conservation of the volume of the material elongation of the material must occur. Here tension control is used to maintain inter-stand tension so that each stand may roll independently of the stands on either side of it. [1]

As it was not possible to build a steel rolling mill or a hot aluminium mill with the resources available to the project, a paper unwind, rewinder was chosen as it is relatively simple to build and can clearly demonstrate the principles of tension control and how this can be achieved with the use of AC motors.

2. SYSTEM DESCRIPTION

In most paper rolling applications the paper is wound off the unwinder and passes into a process at the line (paper) speed and tension required by the process. The same criterion generally apply to winders where the processed paper is rewound onto a reel. The objective of the control is to maintain

tension at a specified line speed. In order to start the simulation process a system description is required with the relevant models for the system.

The paper rewinder being considered for the GTCS test bed system is shown in Fig. 1. The paper is initially on the unwinder and is wound onto the winder. Two three phase vector controlled AC induction motor drives are used to make the AC motors appear as DC motors [2]. The master controller is used to control the speed of the paper and the paper tension using the AC drives as torque controllers. The paper passes under two guide rolls and over a roller that is supported on force transducing bearings to provide the tension feedback required for closed loop tension control.

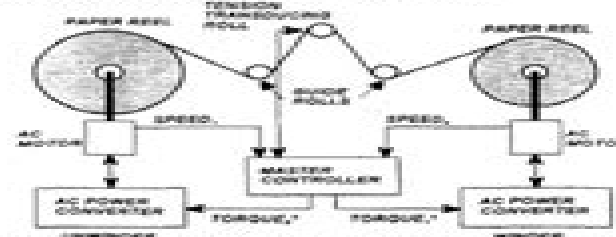


Fig. 1. Generic Tension Control System Test Bed

3. MECHANICAL SYSTEM MODELLING

The standard electrical torque equation for the AC motors appears in eq. 1. The electrical torque consists of an inertia torque, a frictional torque and paper tension torque. As the motor and load are to be directly coupled with a torsionally stiff coupling the motor inertia is lumped together with load inertia as is the frictional resistance of the motor and load. The corresponding differential equation for both the winder and unwinder is therefore:

$$T_e = J_{(R)} \cdot \frac{d^2\theta}{dt^2} + B \cdot \frac{d\theta}{dt} + PT \cdot R \quad (1)$$

$$\begin{aligned} J_{(R)} &= J_{\text{motor}} + J_{\text{load}} & \text{kgm}^2 & & PT &= \text{Paper Tension N} \\ B &= B_{\text{motor}} + B_{\text{load}} & \text{Nmms}^{-1} & & R &= \text{Reel Radius m} \\ T_e &= \text{Electrical Torque Nm} & & & \theta &= \text{Reel Angle rad} \end{aligned}$$

4. PAPER MODEL

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