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DEVELOPMENT OF DIGITAL CONTROL SYSTEM FOR CURRENT AND TEMPERATURE CONTROL OF AN ELECTRODIALYSER

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Black liquor, the liquid effluent of the Embilipitiya pulp mill, is a severe pollutant, but contains valuable chemicals such as sodium hydroxide and lignin. The black liquor of the Embilipitiya paper mill has successfully been converted into a colourless liquor by processing it in the laboratory scale electrodialyser developed at the Dept. of Chemical Engineering. This unit consists of three chambers, namely the cathode, anode and black liquor chambers that are separated by membranes.

As the electrodialysis progresses, the conductivity of the product formed in each of these chambers varies such that the total resistance of the electrodialyser has the following characteristics. Total resistance is high at the beginning and is then followed by a gradual decrease to a minimum before it becomes high again ending the recovery process. As a consequence, the current passing through the electrodialyser tends to fluctuate unless the supply voltage is varied accordingly. Thus, a control system is imperative to maintain the desired current. Moreover, for a successful parametric study of the electrodialyser performance, it is necessary to vary the current through the electrodialyser in a desired manner and a current controller is needed to achieve this.

Of all three chambers of the electrodialyser, the anode chamber has the lowest conductivity. Therefore, when a current as high as 1 ampere passes through, the temperature of the anode liquor rises to about 70 to 85 °C. High temperatures in the anode liquor result in boiling and evaporation losses of the anode liquor, physical damage to the anode-side membrane, and development of leaks in the unit. Thus, it is necessary to control the temperature of the anode subjected to an allowable maximum value. This is also an important feature required for the parametric study of the system.

The objective of this research has been to develop a complete digital control system for the current and temperature control of the electrodialyser. The power electronic circuit for controllable power supply, current measuring circuits, and the thermo sensor circuits were developed locally. The digital control system was developed using a personal computer equipped with a process/computer interface card. The digital control system has two PID controllers running in parallel, but only one running at a time and switching in between to compromise maximum current and temperature ratings. Anti-windup and bumpless transfer techniques are implemented to guarantee good performance during the switching and actuator saturation. A fault diagnosis technique is also implemented to monitor the breakdown of the dialysis process due to membrane failure.

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