



## Design and tuning of feedback controllers: effects on proteins ultrafiltration process modeled by a hybrid system

Stefano Curcio\*, Vincenza Calabrò, Gabriele Iorio

*Department of Engineering Modeling, University of Calabria, Rende (CS) – Italy  
Tel. +39 0984 4967-11, 03, 09; Fax: +39 0984 496671; email: stefano.curcio@unical.it*

Received 3 September 2010; Accepted 3 January 2011

---

### ABSTRACT

The focus of the paper was the description of a feedback control system that, based on the predictions of a previously formulated hybrid neural model, allowed improving the performance of proteins UF, carried out in pulsating conditions. The behavior of three classical feedback controllers, i.e., proportional (P), proportional integral (PI) and proportional-integral-derivative (PID), were compared and analyzed in different situations. The characteristic equation defining each type of controller was added to the already developed hybrid model in order to obtain the true closed-loop responses, thus allowing achieving a proper design and an accurate tuning of the controllers. It was observed that when no control action occurred, the permeate flux tended to progressively decay and that a proportional control was capable to reduce this decay only to a limited extent. The differences between the actual permeate flux and the desired set-point tended, instead, to nil when a properly tuned PI or PID controller was utilized. The selection of the best values for the adjustable parameters of the controller was eventually attained by a time-integral performance criterion, i.e., the minimization of the integral of the time-weighted absolute error (ITAE), using, as a starting point, the values provided by the application of the Ziegler-Nichols tuning method.

*Keywords:* Hybrid neural modeling; Membrane; Permeate flux decay; PID; ITAE; Ziegler-Nichols

---

---

\*Corresponding author.