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Modelling and Control of Milk Fermentation Process in Biochemical Reactor

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Abstract : The biochemical industry is one of the most important modern industries. Biochemical reactors are crucial devices of the biochemical industry. The essential bioprocess carried out in bioreactors is the fermentation process. A thorough insight into the fermentation process and the knowledge how to control it are essential for effective use of bioreactors to produce high quality and quantitatively enough products. The development of the control system starts with the determination of a mathematical model that describes the steady state and dynamic properties of the controlled plant satisfactorily, and is suitable for the development of the control system. The paper analyses the fermentation process in bioreactors thoroughly, using existing mathematical models. Most existing mathematical models do not allow the design of a control system for controlling the fermentation process in batch bioreactors. Due to this, a mathematical model was developed and presented that allows the development of a control system for batch bioreactors. Based on the developed mathematical model, a control system was designed to ensure optimal response of the biochemical quantities in the fermentation process. Due to the time-varying and non-linear nature of the controlled plant, the conventional control system with a proportional-integral-differential controller with constant parameters does not provide the desired transient response. The improved adaptive control system was proposed to improve the dynamics of the fermentation. The use of the adaptive control is suggested because the parameters’ variations of the fermentation process are very slow. The developed control system was tested to produce dairy products in the laboratory bioreactor. A carbon dioxide concentration was chosen as the controlled variable. The carbon dioxide concentration correlates well with the other, for the quality of the fermentation process in significant quantities. The level of the carbon dioxide concentration gives important information about the fermentation process. The obtained results showed that the designed control system provides minimum error between reference and actual values of carbon dioxide concentration during a transient response and in a steady state. The recommended control system makes reference signal tracking much more efficient than the currently used conventional control systems which are based on linear control theory. The proposed control system represents a very effective solution for the improvement of the milk fermentation process.

Keywords : biochemical reactor, fermentation process, modelling, adaptive control
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