IN THE NAME OF GOD

COMPUTER SIMULATION OF UREA THERMAL HYDROLYSIS REACTOR

BY

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To My Devoted Parents, Affable Sister,
and Deceased Sister

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Abstract

Computer Simulation of Urea Thermal Hydrolysis Reactor

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Two kinetic models for the urea thermal hydrolysis reaction have been developed. Kinetic model 1 has been considered as the reverse steps of urea synthesis reaction. Kinetic model 2 is an irreversible reaction in which carbon dioxide and ammonia gases are produced as products. The validity of the proposed kinetic models has been checked by comparing the results predicted by the models with design and plant data. The kinetic model 1 is a good one to predict the conversion of urea, but it is not a good kinetic model to predict the concentration of carbon dioxide and ammonia gases. The kinetic model 2 gives much better results than the kinetic model1.

The two kinetic models were used to investigate the steady state behavior of the industrial urea thermal hydrolysis reactor. A detailed steady state model described by a set of ordinary differential and nonlinear algebraic equations (ODAEs) was developed to predict the behavior of the urea thermal hydrolysis reactor. The model was implemented in MATLAB 5.3 software. The implementation of the model in this package was primarily concerned with the solution of the ODAEs to carry out steady state simulation of the process. The model has been validated against design and plant data.

Results of the simulation of the reactor show that the conversion of urea and the concentrations of carbon dioxide and ammonia gases increase along the reactor. Also, the temperature of the fluid passing through the reactor decreases along the reactor slowly. By using the model, the influence of a number of operating parameters was assessed and considerable insight into the reactor performance was obtained. The results of this study suggest that we could make some improvement by changing the operating conditions.

Keywords: urea, thermal hydrolysis, urea removal plant, UNIQUAC equation of state, urea thermal hydrolysis reactor, and nonlinear equations.

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