

REAL TIME COMPUTER STUDIES ON A FLUIDIZED BED  
HEAT EXCHANGER SYSTEM

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## ABSTRACT

The work reported in this thesis explores the possibility of optimization and multivariable computer control of a laboratory model fluidized bed heat exchanger system. Such systems can form a part of energy generating fluidized bed reactors.

A simplified laboratory model water-sand fluidized bed heat exchanger system has been fabricated with a facility of continuous solid movement. The overall laboratory model fluidized bed heat exchanger can be envisaged as a multivariable system in which the controlled variables are the outlet cooling water temperature and bed porosity and the manipulative variables are the two components of liquid flow and solid feed rates. The disturbances occur in the form of small load fluctuations (flow rate of cooling water through the heat exchanger tube), set point disturbances and fluctuations in the temperature of solid particles and heat losses to the surroundings. A control strategy becomes necessary in order to operate the system in the presence of these disturbances.

A process control computer PDP8/e is interfaced to the laboratory model fluidized bed heat exchanger system for carrying out real time studies. The development of appropriate software and instrumentation for this work are discussed in

detail. The computer interfaced instrumentation system developed for this study includes circuit blocks for measuring temperatures and bed porosity and for actuating process flow valves for identification and control purposes.

A procedure for deriving steady state and dynamic models for the process system, from physical considerations, is developed. The steady state model is used for maximizing heat transfer coefficient for the heat exchanger at the system operating conditions. The derived dynamic model is tested and its two unknown parameters are evaluated using an on-line model matching technique. However, the load dependent and nonlinear distributive nature of the derived model poses considerable difficulties in arriving at its linearized version. This justified the use of an on-line computer for identifying a system model from input-output data.

An on-line identification algorithm for obtaining a time series model for the multivariable system is developed. The developed identification technique is based on least squares correlation using PRBS sequences. A transfer matrix and state variable representation in discrete time are obtained from the time series model.

Finally the developed linear models are used for designing system controllers for on-line implementation. Attention is particularly given to the proper pairing of input and output

variables for feedback control. A number of controller strategies have been examined and it is concluded that the most acceptable system responses, for the controlled system, are obtained with a combination of static feedforward and a dead beat feedback controller.

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