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1:00 pm

in Room 221 MAE-A

Dynamics and control of solar thermochemical reactors

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Abstract

Solar energy driven thermochemical processes are characterized by the *intermittent* nature of solar irradiation. In contrast to many conventional chemical and energy conversion processes they are *inherently transient*. Understanding and controlling their dynamic behavior is therefore critical for efficient and safe operation.

The methodology for deriving physically based *dynamic models* using unsteady mass and energy conservation coupled to chemical kinetics is outlined. This methodology is then applied to three pertinent solar thermochemical reactors: 1) a directly irradiated continuously operated reactor for the *steam gasification of petroleum coke*, 2) a directly irradiated, continuously operated catalytic reactor for the *steam reforming of hydrocarbons*, and 3) an indirectly irradiated batch-operated packed bed reactor for the *carbothermic reduction of zinc oxide*. Model *parameter identification* and *validation* is accomplished by comparing simulated and experimentally measured temperatures and outlet compositions.

A *model-based linear feedback LQG/LTR controller* is designed. The controller is supplemented with a feed-forward channel anticipating system behavior and enhancing controller response time.

Simulations of the controlled reactor system with real solar irradiation data indicate *improved product composition* throughout transient solar input phases and an *increase of solar-tochemical energy conversion efficiency* by 6.2% vis-à-vis the uncontrolled system.

