Modeling *in-situ* shale oil retorting

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A mathematical model for oil shale retorting is described that considers kerogen pyrolysis, oil coking, residual carbon gasification, carbonate mineral decomposition, water-gas shift, and phase equilibrium reactions. Reaction rate temperature-dependence is described by Arrhenius kinetics. Combustion of gas phase hydrocarbons, CO and H_2 is assumed instantaneous above ignition temperature subject to oxygen availability. Fractured rock is modeled as a bi-continuum consisting of a fracture region, in which advective and dispersive gas transport occur, and a rock matrix, in which diffusive transport occurs. Gas species transfer between fracture and matrix regions can be modeled by partial differential equations (PDEs) for radial diffusion or by a simpler first-order mass transfer model. Heat transport is modeled in an analogous manner with advective and diffusive transport in fractures and with heat transfer to the matrix described by a thermal diffusion PDE or a first-order model. First-order mass and heat transfer coefficients are computed by a theoretical model from diffusivities and rock block size. The governing equations are solved using a 3-D finite element formulation. The model was compared to data from a laboratory retort experiment on a 17 cm diameter x 17.2 cm block of Colorado oil shale reported by Gregg et al. (1980). Both first-order and radial diffusion formulations yielded reasonable agreement between observed and simulated oil and gas production. Results of a hypothetical *in situ* retort problem are also presented to evaluate sensitivity of oil production to rock fragment size, airflow rate, air composition and water leakage into the retort.