Catalytic Reaction in a Flat Particle

exb1

Variables and parameters:

- y: dimensionless concentration
- x: dimensionless coordinate ($0 \leq x \leq 1$)
- ϑ: Thiele modulus (bifurcation parameter: $\lambda := \vartheta^2$)
- γ: dimensionless energy of activation
- β: dimensionless parameter of heat evolution, $\beta = 0.4$

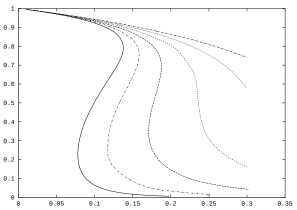
ODE boundary-value problem

$$\frac{d^2 y}{dx^2} = \vartheta^2 y^m \exp\left[\frac{\gamma\beta(1-y)}{1+\beta(1-y)}\right]$$

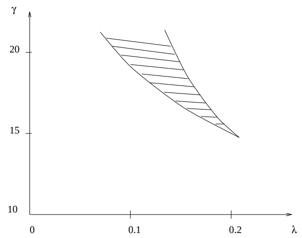
$$\frac{dy(0)}{dx} = 0, \quad y(1) = 1.$$

We choose the first-order reaction ($m = 1$).

Figures:

1 

Branching diagrams $y_1(0)$ versus λ for six values of the second parameter γ: $\gamma = 20$ (left profile), $\gamma = 18$, 14, 12, and $\gamma = 10$ (right profile).

2 

(λ, γ)-parameter chart with two turning point curves.

Comments and explanations:
Original source of the model: V. Hlavacek, M. Marek, M. Kubíček: Modelling of chemical reactors X. Multiple solutions of enthalpy and mass balances for a catalytic reaction within a porous catalyst particle. Chem. Eng. Sci. **23** (1968) 1083–1097.
The curves in Figures 1 and 2 are a manifestation of a cusp catastrophe; the two fold curves in Figure 2 merge in the cusp point.