

A Study about Exothermic Chemical Reactor by ASM Approach Strategy

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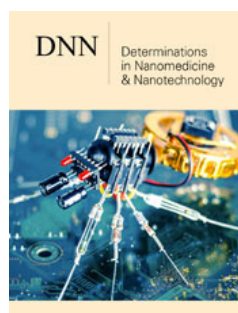
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Abstract

In this paper, our aims are accuracy, capabilities and power at solving set of the complex non-linear differential at the reaction chemical. As all experts know most of engineering actual systems behavior in practical are nonlinear process and analytical scrutiny these nonlinear problems are difficult or sometimes impossible. Our purpose is to enhance the ability of solving the mentioned nonlinear differential equations at chemical engineering and similar issues with a simple and innovative approach which entitled "Akbari-Sara's Method" or "ASM".

Introduction and Theatrical Formulation

In this literature, we have set nonlinear differential equations governing of kinetic the plug reactor to chemical reaction [1,2], that can be investigated and resolved response and the actual reactions at reactors for scientists and engineers is very important, because they know the real answer for analysis and design of reactors against chemical reactions are important and highly sensitive in of executive tasks are created. Other methods compared to ASM do not have this ability to gain the solution of the presented problem in high precision and accuracy so nonlinear differential equations such as the presented problem in this case study should be solved by utilizing new approaches like AGM, Akbari Ganji Method [3-8]; (Figure 1). We consider a well-mixed continuous stirred tank reactor with the reaction and set of nonlinear differential equations. parameters F (the flow rate), C_{A0} (the initial molar concentration), T_{A0} (the initial temperature), Q (the rate of heat input to the reactor), V (the volume of the reactor), E , ΔH , k_0 (the pre-exponential constant reaction), c_p and ρ denote the heat capacity and density of the fluid in the reactor.



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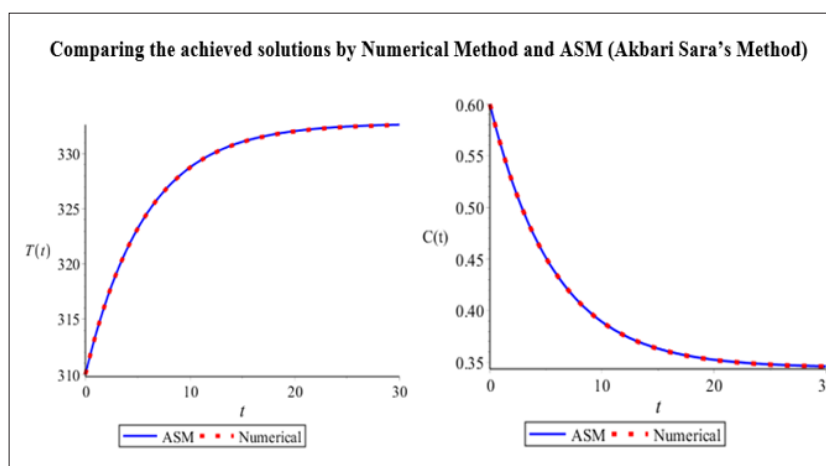
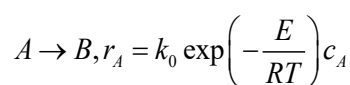


Figure 1: A comparison between ASM and Numerical solution for concentration and temperature.



$$IC : c(0) = c_0, T(0) = T_0$$

Set of nonlinear differential equations as follows:

$$V \frac{d}{dt} C_A(t) = F [C_{A0} - C_A(t)] - k_0 \text{Exp} \left(-\frac{E}{RT(t)} \right) V C_A(t)$$

$$V \frac{d}{dt} T_A(t) = F [T_{A0} - T_A(t)] + k_0 \left(\frac{-\Delta H}{\rho c p} \right) \text{Exp} \left(-\frac{E}{RT(t)} \right) V C_A(t) + \frac{Q}{\rho c p}$$

The solution of the mentioned problem by ASM will be obtained as follows:

$$C(t) := \frac{\Gamma}{\Psi} - \frac{T_0^2 \Delta^2}{\Psi} \text{Exp} \left(\frac{-\Psi t}{\Delta T_0^2} \right)$$

$$T(t) := \frac{\Gamma_1}{\Psi_1} - \frac{\Delta_1^2 T_0^2}{\Psi_1} \text{Exp} \left(-\frac{\Psi_1 t}{\Delta_1 T_0^2} \right)$$

The following new variables are introduced as:

$$\Psi = T_0^2 c_0 \eta k_0 e^{\frac{2\varepsilon}{T_0}} - c_0^2 \eta^2 \varepsilon e^{\frac{2\varepsilon}{T_0}} + 2T_0^2 \beta c_0 \eta e^{\frac{\varepsilon}{T_0}} + T_0 \beta c_0 \eta \varepsilon e^{\frac{\varepsilon}{T_0}} - T_0^2 \alpha_1 \eta e^{\frac{\varepsilon}{T_0}} - \alpha_2 c_0 \eta \varepsilon e^{\frac{\varepsilon}{T_0}} - T_0^3 \beta^2 + T_0^2 \alpha_2 \beta$$

$$\Gamma = T_0 \left(\Psi - 2T_0^2 \beta c_0 \eta e^{\frac{\varepsilon}{T_0}} + T_0^3 \beta^2 + T_0 c_0^2 \eta^2 e^{\frac{2\varepsilon}{T_0}} + 2T_0 \alpha_2 c_0 \eta e^{\frac{\varepsilon}{T_0}} + T_0 \alpha_2^2 \right); \Delta \Leftarrow \eta c_0 e^{\frac{\varepsilon}{T_0}} - \beta T_0 + \alpha_2$$

$$\Psi_1 = -T_0^2 c_0 k_0^2 e^{\frac{2\varepsilon}{T_0}} + c_0^2 \eta k_0 \varepsilon e^{\frac{2\varepsilon}{T_0}} - 2T_0^2 \beta c_0 k_0 e^{\frac{\varepsilon}{T_0}} - T_0 \beta c_0 k_0 \varepsilon e^{\frac{\varepsilon}{T_0}} + T_0^2 \alpha_1 k_0 e^{\frac{\varepsilon}{T_0}} - \alpha_2 c_0 k_0 \varepsilon e^{\frac{\varepsilon}{T_0}} - T_0^2 \beta^2 c_0 + T_0^2 \alpha_1 \beta$$

$$\Gamma_1 = c_0^3 \eta k_0 \varepsilon e^{\frac{2\varepsilon}{T_0}} - T_0 \beta c_0^2 k_0 \varepsilon e^{\frac{\varepsilon}{T_0}} - T_0^2 \alpha_1 c_0 k_0 e^{\frac{\varepsilon}{T_0}} + \alpha_2 c_0^2 k_0 \varepsilon e^{\frac{\varepsilon}{T_0}} - T_0^2 \alpha_1 \beta c_0 + T_0^2 \alpha_1^2; \Delta_1 = k_0 c_0 e^{\frac{\varepsilon}{T_0}} - \beta c_0 - \alpha_1$$

$$\alpha_1 := \frac{F}{V} c_0; \alpha_2 := \frac{F}{V} T_0 + \frac{Q}{\rho c p V}; \beta := \frac{F}{V}; \eta := k_0 \left(-\frac{\Delta H}{\rho c p} \right); \varepsilon := -\frac{E}{R}$$

By selecting the physical values at below:

$$V := 20(L); R := 8.314 \frac{J}{mol.K}; c_0 := 0.6 \frac{mol}{L}; T_0 := 310K; \Delta H := -4.78.10^4 \frac{J}{mol}; k_0 := 7.20.10^{-2} \text{min}^{-1}; E := 83.1 \frac{J}{mol}; cp := 0.539 \frac{J}{g.K}; \rho := 1000 \frac{g}{L}; F := 2 \frac{L}{min}; Q := 100 \frac{L}{min}$$

The solution is rewritten as follows:

$$C(t) := 332.7146555 - 22.71465617e^{-0.1745968863t}$$

$$T(t) := 0.3447209382 + 0.2552790620e^{-0.1747717806t}$$

Acknowledgement

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