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Review Article

Chemical Reactors with Exothermic Reactions on the Plug Flow and Study it by New Approach Strategy ASM

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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.

Keywords: reaction chemical, nonlinear process, chemical engineering, ASM.

INTRODUCTION AND THEATRICAL FORMULATION

In this literature, we have set nonlinear differential equations governing of kinetic the plug reactor to chemical reaction 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 [1-7].In recent years, analytical methods in solving nonlinear differential equations have been presented and created by Mohammadreza Akbari, these methods are called AKLM [8] (Akbari Kalantri Leila Method in August 2020), ASM [9,10] (Akbari Sara's Method in August 2019) and AYM[11] (Akbari Yasna's Method in April 2020), MR.AM (MohammadReza Akbari Method in November 2020) and IAM (Integral Akbari Method in November February 2021).

Describe problem and mathematical Formulation

We consider a well-mixed continuous stirred tank reactor fig (1) with the reaction and set of nonlinear differential equations. Parameters F (the flow rate), c_0 (the initial molar concentration), T_0 (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.

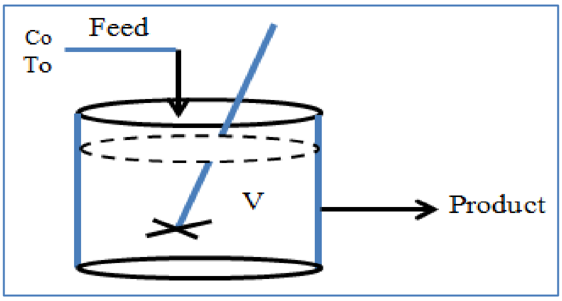

Fig-1: The schematic diagram of the physical model

$$A \to B \quad , \quad r_A = ko\exp\left(-\frac{E}{R\,T}\right)c_A \; ; \qquad IC: \; c(0) = co \quad , \quad T(0) = To$$

Set of nonlinear differential equations as follows:

$$V\frac{\mathrm{d}}{\mathrm{d}t}C_A(t) = F\left[C_{A0} - C_A(t)\right] - ko\,Exp\left(-\frac{E}{R\,T(t)}\right)V\,C_A(t)$$

$$V\frac{\mathrm{d}}{\mathrm{d}t}T_A(t) = F\left[T_{A0} - T_A(t)\right] + ko\left(\frac{-\Delta H}{\rho\,cp}\right)Exp\left(-\frac{E}{R\,T(t)}\right)V\,C_A(t) + \frac{Q}{\rho\,cp}$$

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

$$c(t) := \frac{\Gamma}{\psi} - \frac{To^2\Delta^2}{\psi}Exp\left(\frac{-\psi\,t}{\Delta\,To^2}\right) \quad ; \quad T(t) := \frac{\Gamma 1}{\psi 1} - \frac{\Delta 1^2\,To^2}{\psi 1}Exp\left(-\frac{\psi 1\,t}{\Delta 1\,To^2}\right)$$

The following new variables are introduced as:

$$\psi = To^2\,co\,\eta\,ko\,\mathrm{e}^{-\frac{2\varepsilon}{To}} - co^2\eta^2\varepsilon\,\mathrm{e}^{-\frac{2\varepsilon}{To}} + 2\,To^2\beta\,co\,\eta\,\mathrm{e}^{-\frac{\varepsilon}{To}} + To\,\beta\,co\,\eta\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To^2\alpha 1\,\eta\,\mathrm{e}^{-\frac{\varepsilon}{To}} - \alpha 2\,co\,\eta\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To^3\beta^2 + To^2\alpha 2\,\beta$$

$$\psi 1 = -To^2\,co\,ko^2\mathrm{e}^{-\frac{2\varepsilon}{To}} + co^2\eta\,ko\,\varepsilon\,\mathrm{e}^{-\frac{2\varepsilon}{To}} - 2\,To^2\beta\,co\,ko\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To\,\beta\,co\,ko\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} + To^2\alpha 1\,ko\,\mathrm{e}^{-\frac{\varepsilon}{To}} + \alpha 2\,co\,ko\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To^2\beta^2 co + To^2\alpha 1\,\beta$$

$$\Gamma 1 = co^3\eta\,ko\,\varepsilon\,\mathrm{e}^{-\frac{2\varepsilon}{To}} - To\,\beta\,co^2 ko\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To^2\alpha 1\,co\,ko\,\mathrm{e}^{-\frac{\varepsilon}{To}} + \alpha 2\,co^2 ko\,\varepsilon\,\mathrm{e}^{-\frac{\varepsilon}{To}} - To^2\alpha 1\,\beta\,co + To^2\alpha 1^2 \; ; \quad \Delta 1 = ko\,co\,\mathrm{e}^{-\frac{\varepsilon}{To}} + \beta\,co - \alpha 1$$

By selecting the physical values at below:

$$V := 20\,(L); R := 8.314\,\frac{J}{mol.K}; co := 0.6\frac{mol}{L}; To := 310\,K; \Delta H := -4.78\cdot 10^4\frac{J}{mol}; ko := 7.20\cdot 10^{-2}\mathrm{min}^{-1}; E := 83.1\frac{J}{mol}; cp := 0.539\,\frac{J}{g.K}; \rho := 1000\frac{g}{L}; F := 2\frac{L}{\mathrm{min}}; Q := 100\frac{L}{\mathrm{min}}$$

The solution is rewritten as follows:

$$c(t) := 332.7146555 - 22.71465617\,\mathrm{e}^{-0.1745968863\,t}$$

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

Comparing the achieved solutions by Numerical Method and ASM (Akbari Sara's Method)

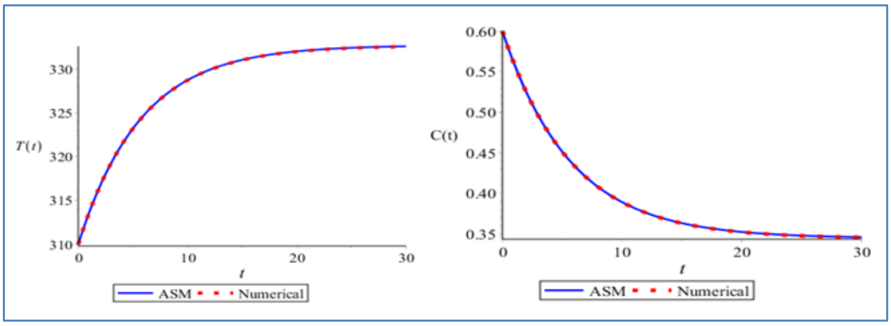

Fig-2: A comparison between ASM and Numerical solution for concentration and temperature

CONCLUSION

In this article, we introduce a innovation method (by M.R.Akbar) in the field of engineering and basic sciences for analytical solution of nonlinear differential equations in the Exothermic Chemical Reactor on the plug flow and so due to the chemical reaction for the concentration as well as the heat generated, we are encountered one complicated set of nonlinear differential equations have been introduced in chemical reaction for plug flow and analyzed completely by Akbari-Sara's Method (ASM), and also the obtained results have been compared with Numerical Method(Runge-Kutte 4th).A modern method (ASM) for solving all kinds of complicate nonlinear differential equations in the engineer field and basic science which can be PDEs and ODEs has been presented.This methods are newly created and they can have high power in analytical solution of all kinds of industrial and practical problems in engineering fields and basic sciences for complicated nonlinear differential equations.

•Acknowledgment, History of AGM, ASM, AYM, AKLM, MR.AM and IAM methods:
AGM (Akbari-Ganji Methods), ASM (Akbari-Sara's Method), AYM (Akbari-Yasna's Method) AKLM (Akbari Kalantari Leila Method), MR.AM (MohammadReza Akbari Method)and IAM (Integral Akbari Methods), have been invented mainly by Mohammadreza Akbari (M.R.Akbari) in order to provide a good service for researchers who are a pioneer in the field of nonlinear differential equations.

*AGM method Akbari Ganji method has been invented mainly by Mohammadreza Akbari in 2014. Noting that Prof. Davood Domairy Ganji co-operated in this project.
*ASM method (Akbari Sara's Method) has been created by Mohammadreza Akbari on 22 of August, in 2019.
*AYM method (Akbari Yasna's Method) has been created by Mohammadreza Akbari on 12 of April, in 2020.
*AKLM method (Akbari Kalantari Leila Method) has been created by Mohammadreza Akbari on 22 of August, in 2020.
*MR.AM method (MohammadReza Akbari Method) has been created by Mohammadreza Akbari on 10 of November, in 2020.
*IAM method (Integral Akbari Method) has been created by Mohammadreza Akbari on 5 of February, in 2021.

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