Design of Reinforcement Learning based Controller for Dynamic Non-Linear Chemical Processes

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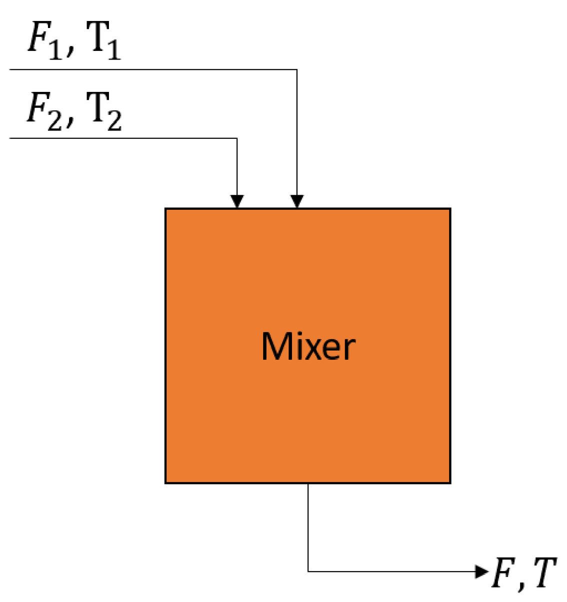
Introduction

- Maintaining a process at desired operating conditions is the primary objective of process control.
- Majority of the systems used in industries are Multiple Input Multiple Output (MIMO).
- Significant process interactions occurring among the key process variables make the system difficult to control.
- Conventional controllers require loop selection and high domain expertise.
- The objective is **to design RL based intelligent control system for complex chemical processes.**

System Description



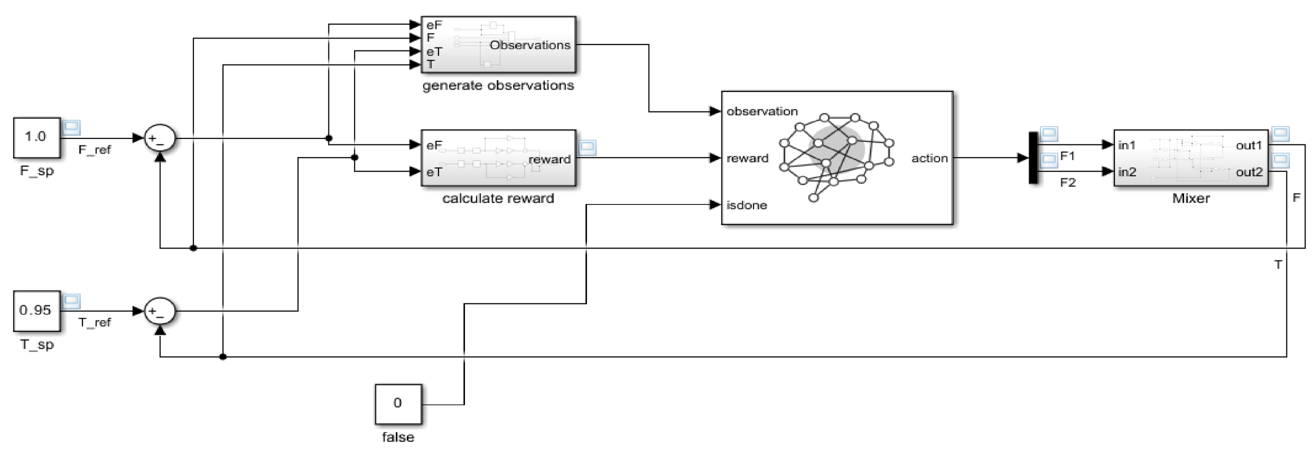
$$\frac{dF}{dt} = \frac{K(F_1 + F_2 - F)}{F}$$

$$\frac{dT}{dt} = \frac{2K(F_1T_1 + F_2T_2 - (F_1 + F_2)T)}{F * F}$$

- F_1, F_2 – Manipulated variables
- F, T – Controlled variables

Methodology

- Reinforcement learning (RL) is the science of decision making.
- RL algorithm can be divided into three categories – Policy based, Value based and Actor critic.
- The Deep Deterministic Policy gradient (DDPG) is an actor critic algorithm designed for continuous action spaces.



Results & discussion

- The model built in Simulink is trained for 2500 episodes.
- The trained model is tested on different set point values of T and F.
- Case 1 (Varying T set points)

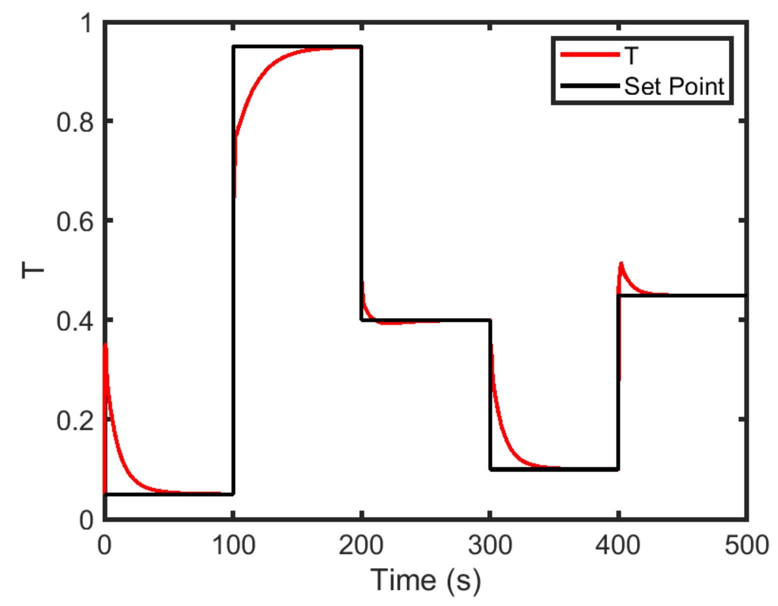


Figure 1

- Case 2 ($T_{sp} = 0.05$, $F_{sp} = 1$)

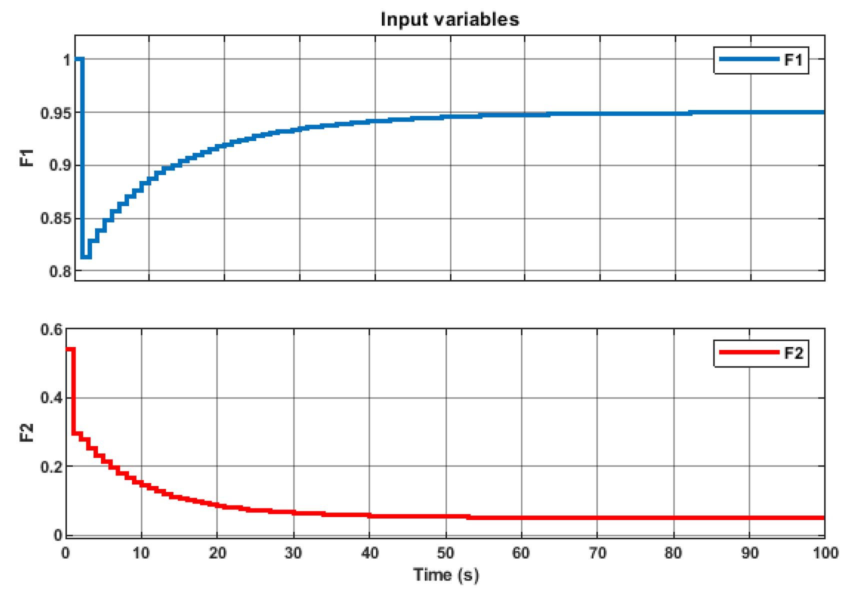


Figure 2: Input variable profile

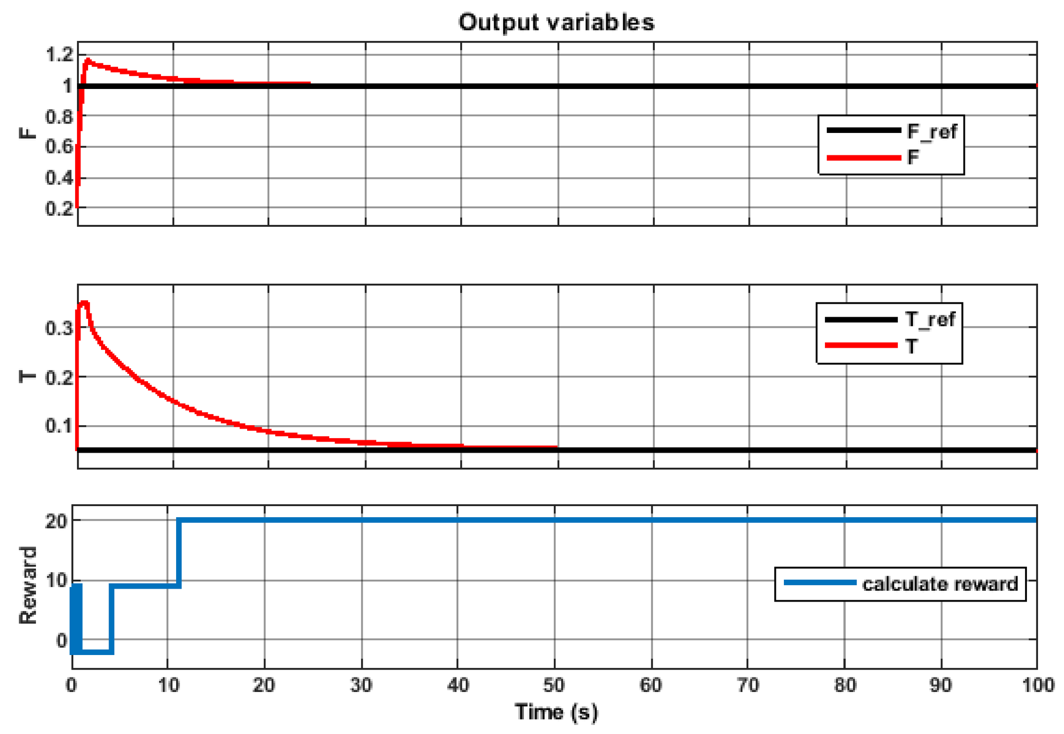


Figure 3: Output variable profile

Conclusions

- The designed controller is able to achieve the T and F set point.
- The trained model is checked on different set point values of T.
- RL controller can serve as an alternative to the conventional control design.

References

- Singh, V., & Kodamana, H. (2020). Reinforcement learning based control of batch polymerisation processes. *IFAC-PapersOnLine*, *53*(1), 667-672.
- Sutton, R. S., & Barto, A. G. (2018). *Reinforcement learning: An introduction*. MIT press.