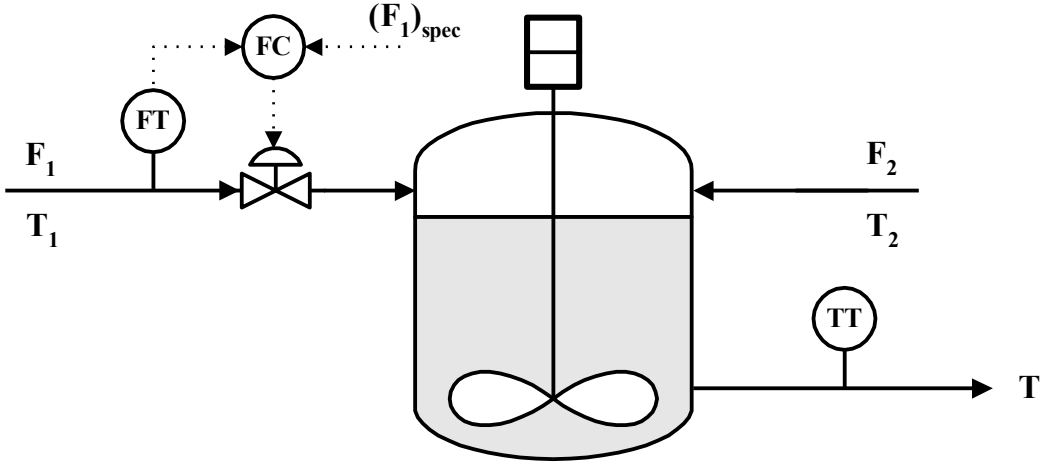
CHE4990 Project #4

CST thermal mixing tank is an equipment used in chemical plants for producing a product stream at a specific temperature T, by mixing two inlet streams of different temperatures T1 and T2, as shown in Figure 1. In this process, let's assume that the mass of liquid in the mixer is 100Kg, the mass flow rate of the stream #2 F2 is fixed at 5Kg/s, and temperatures of the stream #1 and #2, T1 and T2, are fixed at 25C and 75C, respectively. The the mass flow rate of the stream #1 F1 is used for controlling the temperature of the product steam T. The tank level control and mixing efficiency are assumed to be perfect. Based on the energy and material balances, the differential equation below describes the dependence of product stream temperature T on F1.



$$M\frac{dT}{dt} = F_1T_1 + F_2T_2 - (F_1 + F_2)T$$

$$T(t = 0) = 50C$$

$$F_1(t = 0) = 5Kg/s$$

1) Numerically (use both integration and Ronge-Kutta 4th order) determine the product temperature T as function of time, as F_1 is changed from 5Kg/s at t=0s to 4Kg/s at t=10s at a rate of -0.1Kg/s.

2) **Bonus:** In practice, the change in F1 is often realized through changing the specified mass flow rate ${F_1}^{spec}$, which in turn determines F_1 through equation: $\frac{dF_1}{dt} = \frac{1}{\tau}\ ({F_1}^{spec} - F_1)$

Determine the product temperature T as function of time, as ${F_1}^{spec}$ is changed from 5Kg/s at t=0s to 4Kg/s at t=10s at a rate of −0.1Kg/s, with the valve time constant τ=2s, 4s and 6s.