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COLLEGE OF ENGINEERING

DEPARTMENT OF CHEMICAL AND PETROLEUM ENGINEERING
B.ENG. CHEMICAL ENGINEERING PROGRAMME

Process Dynamics and Control I (CHE 531) Assignment I

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PROBLEM STATEMENT

A process liquid with a constant density ρ and a heat capacity C_p is continuously fed at a volumetric flowrate F_i and a temperature T_i into a perfectly mixed tank that has a constant holdup (V). The liquid is heated, by a coil utilizing steam that has a latent heat of vapourization λ_s and a mass flowrate $\dot{m}_s$, to a temperature T and coming out of the tank at a flowrate F. See Figure 1.

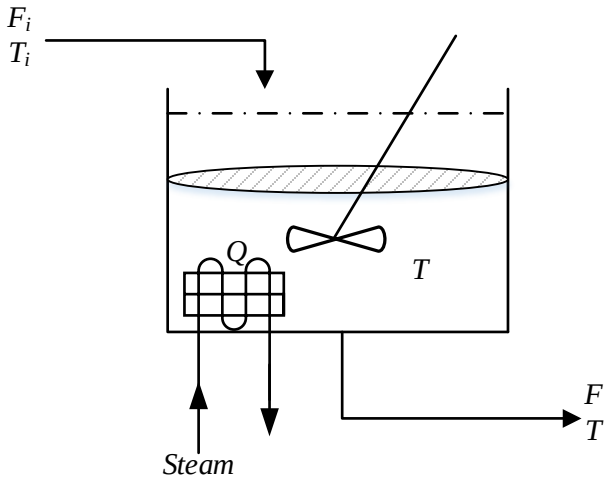

Figure 1: A single-input single-output (SISO) heating tank system

Assuming that the rate of heat transfer by the steam is given by (Equation (1)),

$$Q = \dot{m}_s \lambda_s , \tag{1}$$

taking the process variable of the system to be the temperature (T) of the liquid leaving the tank, the input variable to be the mass flowrate of the steam ($\dot{m}_s$), and the disturbance as the

temperature of the inlet stream (T_i), derive a theoretical dynamic model for the system and, using the data given in Table 1, find its transfer function model.

Table 1. Data for the problem

Variable	**Value**
Liquid density, ρ	$1000\frac{kg}{m^3}$
Liquid heat capacity, C_p	$4.181\frac{kJ}{kg\ ^oC}$
Liquid inlet flowrate, F_i	$0.15\frac{m^3}{\min}$
Tank holdup (volume), V	$3m^3$
Latent heat of vapourization of steam at boiling point, λ_s	$2258\frac{kJ}{kg}$