UCH1603 Process Dynamics and Control

Control of Heat Exchangers

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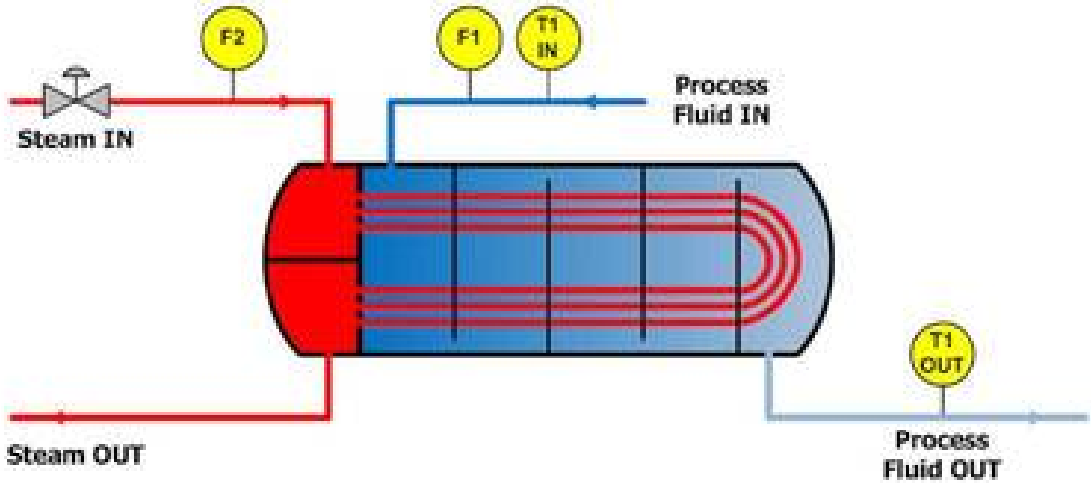
Introduction

To develop a comprehensive control strategy for any control loop, it is important to identify the process variable of interest—called the "controlled variable," the manipulated variable, and the different disturbance variables that directly affect the controlled variable.

Heat Exchanger



Control of Heat Exchanger

Consider the heat exchanger shown in figure (on the previous page). The shell side fluid is the process fluid that is required to be heated to a certain temperature setpoint. The resulting temperature is measured at the outlet of the heat exchanger $T_{1\text{out}}$ (controlled variable).
Heating is achieved by passing steam through the tube side. The more steam passing through the tubes, the more heat is transferred to the process fluid, and vice versa. Control of the steam flow F_2 (manipulated variable) is achieved by throttling a modulating valve installed on the steam inlet side.

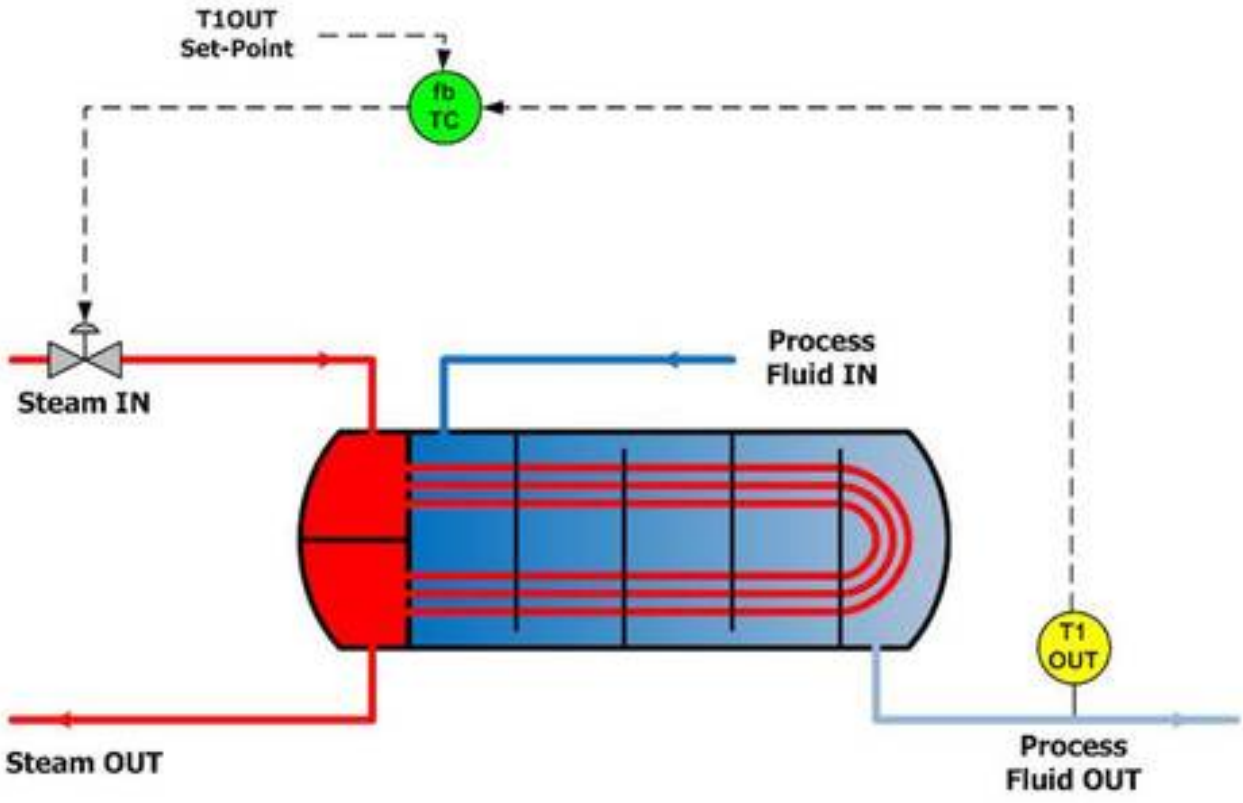
Control of Heat Exchanger (contd..)

Three major disturbances can affect the process fluid outlet temperature:

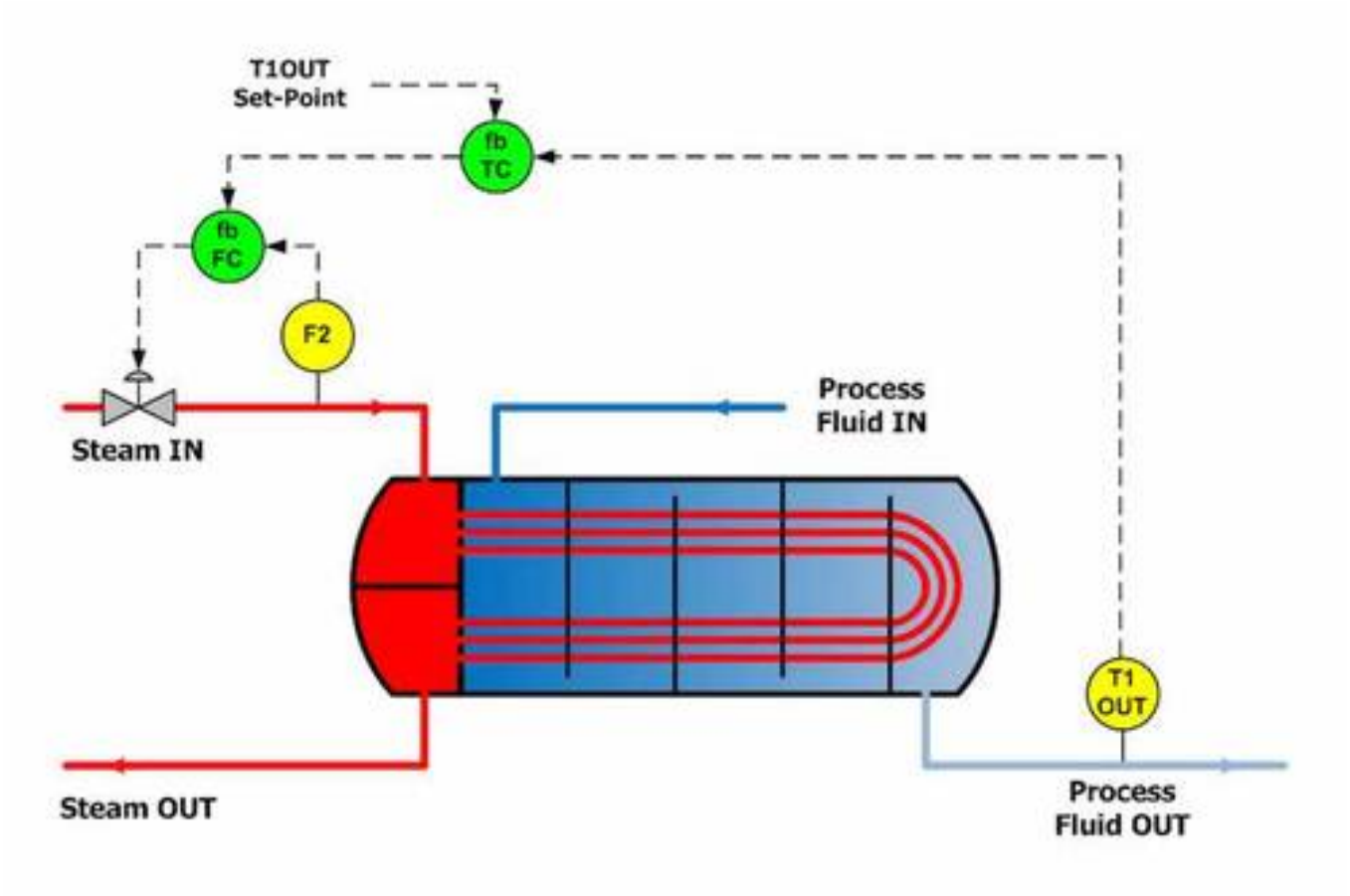
- Changes in process fluid flow rate, F_1
- Changes in process fluid inlet temperature, $T_{1\text{in}}$
- Changes in steam pressure, causing a change in steam flow rate, F_2.

The control objective is to maintain process fluid outlet temperature $T_{1\text{out}}$ at the desired setpoint regardless of disturbances, by manipulating the steam flow rate F_2.

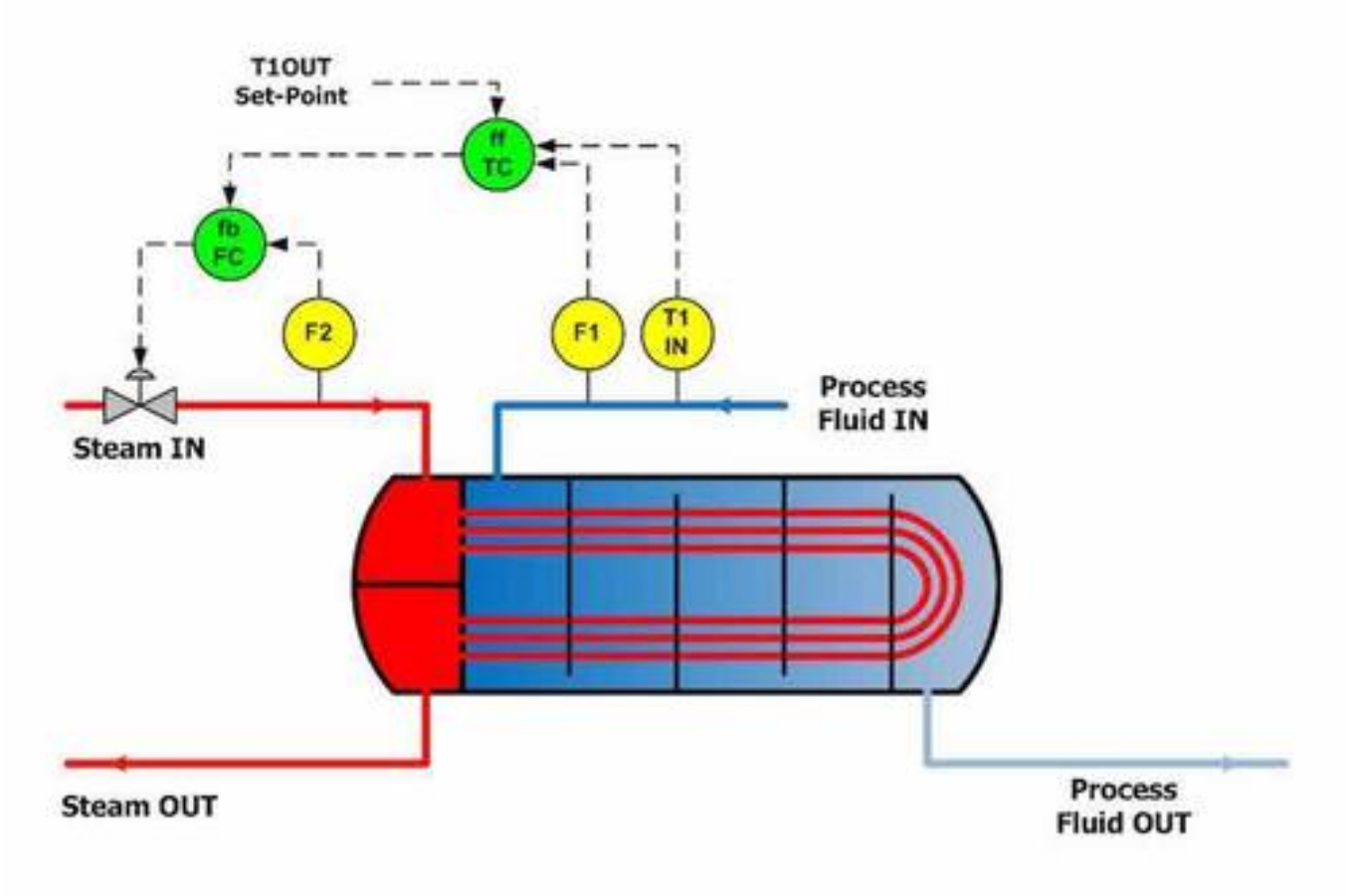
Feedback Control of Heat Exchanger



Cascade Control of Heat Exchanger



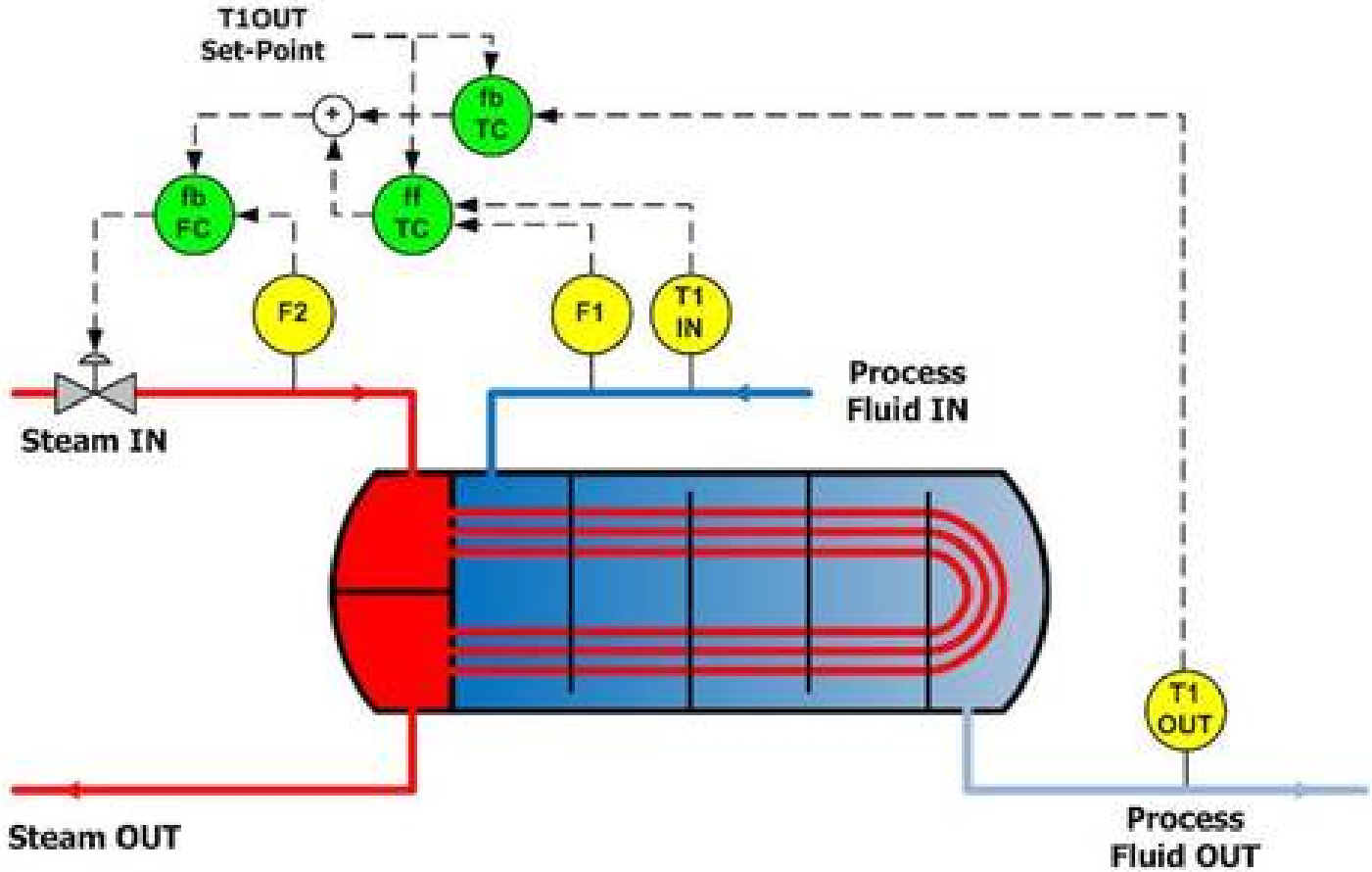
Feedforward Control of Heat Exchanger



Feedforward Control of Heat Exchanger (contd..)

Unlike feedback control, feedforward takes a corrective action when a disturbance occurs. Feedforward control doesn't see the process variable. It sees only the disturbances and responds to them as they occur. This enables a feedforward controller to quickly and directly compensate for the effect of a disturbance.
To implement feedforward control, an understanding of the process model and the direct relationship between disturbances and the process variables is necessary.

Control of Heat Exchanger - Integrated Approach



Control of Heat Exchanger - Integrated Approach

An integrated approach that uses feedback, feedforward, and cascade control is shown in previous page. This approach is more than capable of accommodating heat exchanger control requirements:

- A feedforward loop will handle major disturbances in the process fluid
- A cascaded-flow control loop will handle issues related to steam pressure and valve problems
- A feedback loop will handle everything else.

Combining the three techniques to optimize heat exchanger temperature control is necessary to minimize process variance, maximize product quality, and ensure energy efficiency in petrochemical industries.

References

- www.controleng.com