THE UNIVERSITY OF JORDAN

MECHANICAL ENGINEERING

# College of Engineering & Technology
# Mechanical Engineering Department
# System Dynamics and Control Laboratory

## MODULE V: APPLICATIONS

## EXPERIMENT # 8
## TITLE: HEAT EXCHANGER CONTROL

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# MODULE VIII
# INDUSTRIAL APPLICATIONS: HEAT EXCHANGER

## Lecture Part

### 1.1 Reading assignment

- Review in your heat transfer text book the corresponding chapters on Heat Exchangers technology, operation and types.

### 1.2 Definitions to learn

- The modeling, Performance and control of Heat Exchangers.

### 1.3 Guiding questions to be answered

- What are the main parts of heat exchangers?
- What is meant by PID control?
- What are the equations of the modeled Heat Exchanger system?
- What is the stability of a Heat Exchanger system?
- What are the performance measures of Heat Exchanger system when subjected to a step?
- How the Heat Exchanger system is typically controlled?
- What is the proper control strategy for Heat Exchanger system that is adopted by the industry?

### 1.4 Example to work out

- Refer to text book and lecture notes.

## Laboratory Part

### 1.5 Pre-lab session

- This session is intended to achieve the following (through informal student interaction):
    1. Ascertain that the students have reasonable level of general understanding of the concepts being addressed theoretically.
    2. Familiarity with the equipment to be used, the experimental procedure and the data to be acquired.
- The pre-lab presentation consists primarily on understanding the terminologies of section 1.2, answering the guiding questions of section 1.3, and understanding the overall objective and the experimental procedure. The pre-lab presentation will be due the day of conducting the experiment.
- The final experimental report will be due within a week after conducting the experiment.

### 1.6 Experimental part

- Experiment # 8: Heat Exchanger system control.

### 1.7 Homework/Assignment problems

- TBA.

# EXPERIMENT # 8: PID CONTROL OF PLATE HEAT EXCHANGER SYSTEM

## Apparatus: Gunt Heat Exchanger System

Heat Exchanger systems are widely used in the industry to facilitate heating or cooling of process fluids. There are many types of Heat Exchanger systems such as plate, shell and tube, double pipe, …etc. This experiment is used to illustrate the operation and control of Heat Exchanger systems.

Figure 1.0 depicts a picture of the Gunt Heat Exchanger system with all its accessories. A plate Heat Exchanger system is used to transfer thermal energy to a secondary fluid, the primary hot fluid is heated using an electric heater. A Proportional, Integral and Derivative (PID) controller is used to regulate the temperature of the secondary fluid to a desired user setpoint.

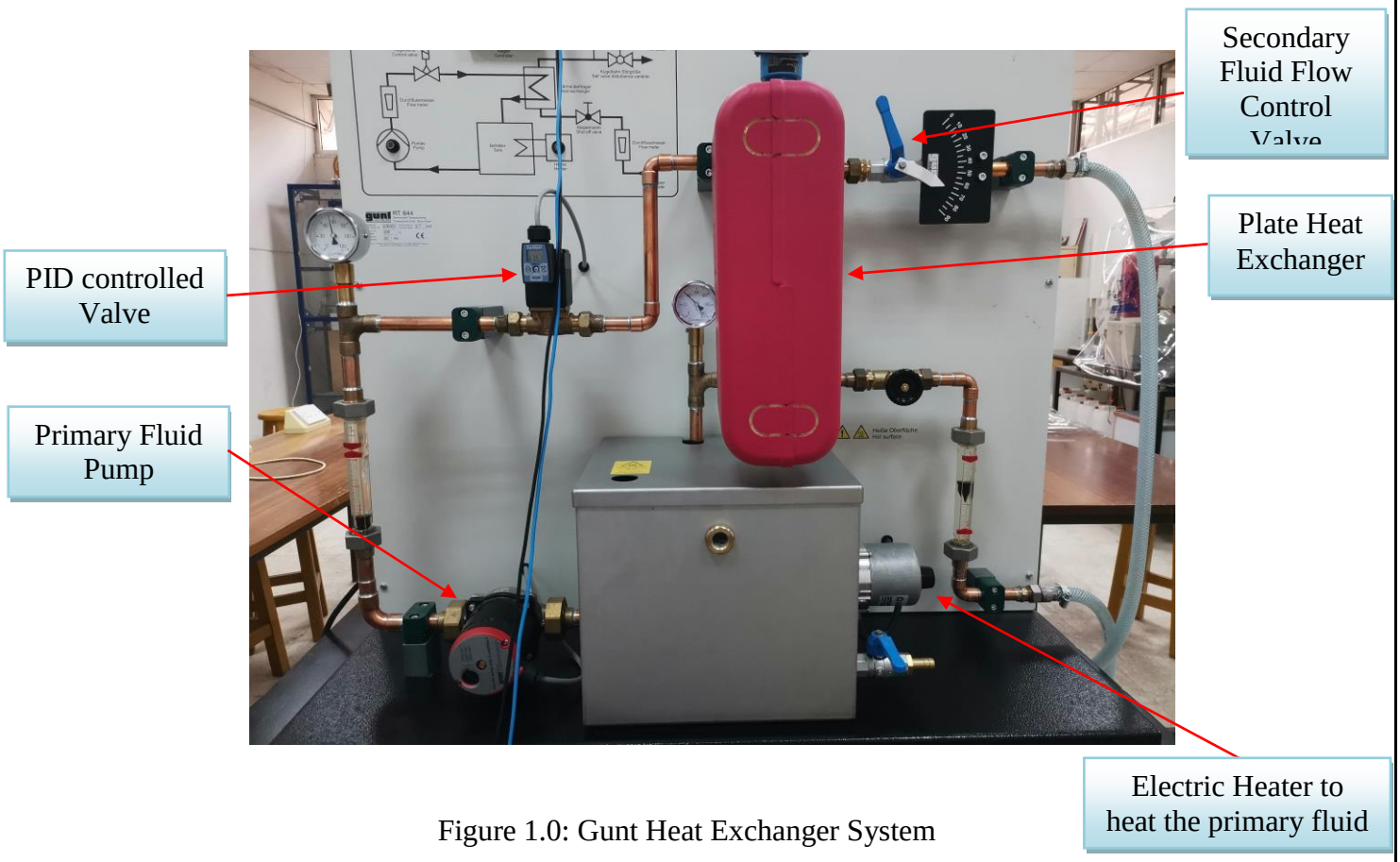


Figure 1.0: Gunt Heat Exchanger System

Figure 2.0 depicts the secondary fluid (i.e. process fluid) main tank and circulating pump. This surge tank is used instead of a tap water because the control laboratory is not equipped with a water supply system.


Figure 2.0: Heat Exchanger secondary fluid main tank

Figure 3.0 illustrates the Piping and Instrument Diagram (P&ID) of the Heat Exchanger System. The students should study these schematics and may get further information from the Gunt site. The components function analysis is a good exercise that helps to strengthen students' skills in Mechanical Design.

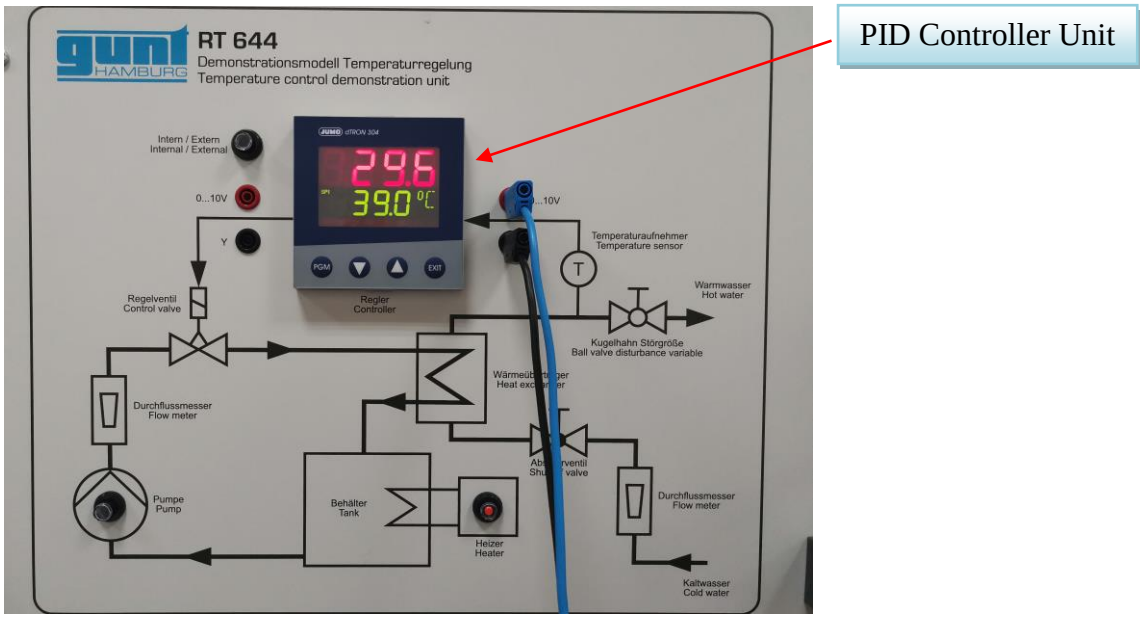


Figure 3.0: P&ID schematics for the Heat Exchanger system

In this experiment, students should analyze the control strategy that might be used in Heat Exchanger system. This Gunt plate Heat Exchanger prototype should provide a good running demonstration of an actual scaled down model. Students are advised to run and verify different operational tests.

Finally, students need to pay special attention for the various used sensors, valves and controllers equipped on the system. The operational flow chart for the Heat Exchanger system should be generated by the students to guarantee the understanding of the used control strategy.

## Objectives

Use the Heat Exchanger Application module in order to:

1. Study the first order system response of the Heat Exchanger systems,
2. Investigate the different types of sensor used in Heat Exchangers,
3. Check system's stability and relate it to system's type,
4. Derive a mathematical model of the Heat Exchanger system, and
5. Create a flow chart of the sequence control strategy that is used in Heat Exchangers.

## Procedure

1. **Students should come up with the operational procedure.**

## Expected Deliverables

- Heat Exchanger mathematical model and simulation
- Plots: system output temperature.
- Heat Exchanger System: drawings using MS Visio and some discussions.
- Block Diagram of the closed loop system.
- Discussions and conclusions: should include
    1. Curves discussions,
    2. Error analysis,
    3. Opinions backed with evidence,
    4. Suggestions to improve the experiment,
    5. Sufficient deductions based on test results,
    6. One-page survey of used Heat Exchanger, and
    7. References properly stated.


## Safety Features and Issues


1. DO NOT start the Heat Exchanger prototype before the instructor's or the Laboratory Engineer approval. All circuit wires must be fully investigated for correctness. Please note that the unit is powered from a single phase 220V electric source, hence extra caution needs to be observed,
2. The primary safety features on all Electronic based units is implemented through Fuses and Trips. However, the emergency stop button or power switched removes all power from the unit in case of emergency,
3. Do not attempt to remove/install the wires when the unit is turned on, and
4. Electrical and mechanical hazards need to be aware of when working in the control laboratory

***Report Due Date:*** *One week from the experiment date*

*Notes:*_____

## References

[1] Gunt technical manual
[2] Private notes

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***First Established on:*** **Spring 2021**