

DEPARTMENT OF CHEMICAL ENGINEERING  
University of Engineering & Technology, Lahore

# Process Heat Transfer

## Lab

# Introduction

In chemical industries, many operations are assisted with heat addition or heat rejection, e.g., petroleum processes involve a variety of heat exchangers and reactors whose performance is very much affected through heat transfer. The process heat transfer lab is designed to familiarize the students with the science of heat transfer so that they are able to apply the basic fundamentals for the smooth running of process equipments.

# List of Equipment

1. Free and Forced Convection Unit
2. Computer-linked Cross-Flow Heat Exchanger
3. Thermal Radiation Unit
4. Boiling Heat Transfer Unit
5. Computer-linked Bench-Top Cooling Tower
6. Concentric Tube Heat Exchanger

## Details of Equipment

### Free and Forced Convection Unit

Heat transfer by simultaneous conduction and convection whether free or forced forms the basis of most industrial heat exchangers and related equipment. Using the instrumentation provided, free and forced convective heat transfer coefficients may be determined for, a flat surface, an array of cylinders, and an array of fins.



## Computer-linked Cross-flow Heat Exchanger

As cross-flow heat exchangers occur in many varied forms throughout industry, it is essential that engineers and technologists should be aware of the performance of such units. Students are able to study the heat transfer between a fluid flowing through a bundle of tubes and other fluid flowing over the outside of tubes.



## Thermal Radiation Unit

Thermal radiation is a mode of heat transfer which differs significantly from the other two modes. The fact that radiant energy transfer occurs across a vacuum is often disturbing to students unless the theory relating to properties of electromagnetic waves has been presented. The engineer is not directly concerned with the mechanism by which heat transfer occurs, but a sound knowledge of the properties and laws relating to the topic is required. By performing a series of simple experiments the student may verify the relevant equations of radiation.



## Boiling Heat Transfer Unit

Boiling and condensation are vital links in the transfer of heat from a hot to a colder region in countless applications e-g thermal and nuclear power generation in steam plants, refrigeration, refining, heat transmission etc. clear understanding of boiling and condensing processes is essential for every mechanical and chemical engineer.



## Computer-linked Bench-top Cooling Tower

The bench-top cooling tower is necessary to study and demonstrate the industrial practice in which a cooling tower is used to cool water from a process. Students can quickly investigate the effects of air flow rate, water flow rate, water temperature, cooling load, air temperature and humidity at inlet, type of packing used and packing density on cooling tower performance.



## Concentric Tube Heat Exchanger

The purpose of this unit is to demonstrate the working principles of industrial heat exchangers in the most convenient way in the laboratory. Experiments show the practical importance of the temperature profiles, co- and counter flow, energy balances, log-mean temperature difference, and heat transfer coefficients. It helps students in understanding heat exchanger design and operation.



# List of Experiments

1. Visual demonstration of convective, nucleate and film boiling.
2. Determination of heat flux and surface heat transfer coefficient up to and beyond critical condition at constant pressure.
3. Steady state determination of heat transfer temperature difference and surface heat transfer coefficient for single tube in a transversely flowing air stream.
4. Deduction of the relationship between Nusselt number, Reynold number and Prandtl number for each of six tube rows.
5. To demonstrate relationship between power input and surface temperature in forced convection.
6. To demonstrate relationship between power input and surface temperature in free convection.
7. To show that the intensity of radiation on a surface is inversely proportional to square of distance of the surface from radiation source.
8. To show that the intensity of radiation varies as the fourth power of source temperature.
9. Observation of processes within a forced draught cooling tower.
10. Effect of cooling load on (i) wet bulb approach (ii) cooling range.
11. To demonstrate the working principles of a concentric tube heat exchanger operating under parallel flow conditions.