# P13624 Conductive Heat Transfer Apparatus

## Preliminary Assembly Plan Draft

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ASSEMBLY PLAN

1. Overview

1.1. Summary

The Chemical Principles Lab has become an important part of the Chemical Engineering curriculum because it allows students to gain real world experience in conjunction with in class lectures. In general, previous methods for teaching conductive heat transfer in the principles lab have been unsuccessful. The goal of P13624 is to design a laboratory testing apparatus that is interactive, durable, adaptable, modular, accurate, and safe. The apparatus will provide an accurate real life application of lectured theory and clearly demonstrate one dimensional conductive heat transfer.

1.2. Purpose

The primary objective of P13624 is to develop a functional, accurate laboratory device that will provide Chemical Engineering students the means to study the principles of conductive heat transfer. The device will allow students the opportunity to collect data, perform calculations related to thermal conductivity, and observe steady state heat flow.

1.3. Objectives

1.3.1. Generates consistent one dimensional heat flow through a specimen.
1.3.2. Provides the means to calculate thermal conductivity.
1.3.3. Yields measurable data that is accurate and consistent, and includes outputs of temperature distribution and heat flux.
1.3.4. Enhances student lab skills.

2. Project Description

![Conductive Heat Transfer Apparatus Diagram]
2.1. Housing & Insulation

2.2. Heating System

2.3. Cooling System

2.4. Temperature Transmission

3. Approval
   
   Approved by:
   
   Team Members:
   Guide:
   Sponsor:

4. Parts List

4.1. Housing & Insulation
   
   Hemlock Wood (Qty: 4, 2x8x8)
   Cabot Australian Timber Oil Transparent Exterior Stain
   Zinc Plated Wood Screws
   Rigid calcium silicate insulation 24x48
   Epoxy Adhesive E-40Ht

4.2. Heating System
   
   5A Variac Variable AC Power Transformer
   High Watt Density Cartridge Heater with Incoloy Sheath

4.3. Cooling System
   
   Refrigeration Flow Unit
   Reducing Coupling (1" – 1/2")
   Reducing Coupling (1/2" – 3/8")
   Water-Resistant Clear Tubing (1" ID x 1ft)
   Water-Resistant Clear Tubing (½" ID x 1ft)
   Water-Resistant Clear Tubing (3/8" ID x 1ft)
   Brass Union Tee (1" OD)

4.4. Temperature Transmission
   
   Insulated Thermocouples (Qty: 2 pkg of 5)
   Multi-Purpose Aluminum (Qty: 1, 3ft length)
   Multi-Purpose Copper Alloy (Qty: 1, 3ft length)
   Ultra Machineable Brass Alloy (Qty: 1, 3ft length)
   Thermocouple Data Logger with USB Interface
   LabView Computer Software Interface

5. Required Resources
5.1. Housing & Insulation

Mechanical Engineering Machine Shop
Bandsaw
Lathe and Milling Equipment

5.2. Heating System

Cartridge Heater and Power Supply reference materials including safety instructions

5.3. Cooling System

Refrigeration unit reference materials

5.4. Temperature Transmission

Mechanical Engineering Machine Shop
Drill press
Bandsaw
LabView reference material

6. Estimated Personnel & Time Required

6.1. Housing & Insulation

Three weeks will be allocated to the assembly of housing and insulation in order to give sufficient time for the hemlock and calcium silicate to be cut into the needed sizes, insulation pieces to be milled to specifications, and epoxy pieces to set. Two team members will be assigned to this task.

6.2. Heating System

The heating system will not require any time for formal assembly because this system only consists of the cartridge heater and variable voltage power supply which will connect together easily. However, one day and one team member will be given to ensure that the heating system works properly.

6.3. Cooling System

One week will be allocated for assembling the cooling system in order to test that all couplings, tubing, and the brass union tee will work adequately. As the refrigeration unit is a piece of equipment that is used ongoing in the chemical engineering lab, cooling system assembly will only be completed as a testing phase and will remain a temporary fixture.

6.4. Temperature Transmission

Temperature transmission assembly will be divided into two sub-assemblies. The first sub-assembly will include all sample preparation procedures. Two weeks and one team member will be allocated to sample preparation. The second sub-assembly will include hardware and software interface development. Five weeks will be allocated to development of the software interface. This sub-assembly will be assigned to two team members and additional assistance will be requested from Professor Sanchez or Professor Richter if necessary.
7. **Procedure**

7.1. **Housing & Insulation**

Assembly will require the parts to be ordered and received. Then the hemlock board will need to be cut into measured sections based on the dimensions drafted in the final CAD drawings. The cut sections will then be assembled into a bottom box container and a top box lid using the wood screws. Slits for thermocouple wires will be made in one side of the bottom housing container. Openings for the cartridge heater wires and the cooling end pipe fixture will be made at each end. After assembly and all openings are created, the box will be stained. Next the calcium silicate will be cut into sections based on the dimensions drafted in the final CAD drawings. One slab of the insulation will then be milled according to specimen specifications to include narrow slots for the thermocouple wires and a groove for the specimen to rest within. A second slab of insulation will need to be milled to include a shallow top groove for the specimen. Finally pieces of insulation will be epoxied to the housing box.

7.2. **Heating System**

There are no formal steps for assembly of the heating system. Refer to the Testing Plan for more information.

7.3. **Cooling System**

Assembly for the cooling system will consist of attaching all tubing and reduced coupling to the refrigeration flow unit. Additionally the brass union tee will need to be attached to the current specimen.

7.4. **Temperature Transmission**

Temperature transmission assembly will be divided into two sub-assemblies. The first sub-assembly will include sample preparation procedures. Aluminum, copper, and brass rods will need to be cut to a length of 18 inches. Each sample will then be milled with a series of equidistant narrow holes. Finally, a hole for the cartridge heater will be bored into the end of each rod. The second sub-assembly will include LabView hardware and software assembly. This will include development and programming of the LabView interface to include observable data collection from the thermocouples.

8. **References**

8.1. Testing Plan

8.2. CAD Drawings

8.3. [Bill of Materials](#)