

Heat Transfer Training Systems

Educational Training Equipment for the 21st Century

Bulletin 687-8C

H-6878 6-Pass Heat Exchanger Demonstrator

Purpose

The Hampden **Model H-6878** 6-Pass Heat Exchanger Demonstrator allows the student to investigate in detail the heat transfer characteristics of several different types of heat exchangers under various flow conditions. The heat exchanger configurations shall consist of the following:

Parallel-Pipe Heat Exchanger:

Designed to be operated under either parallel-flow or counter-flow conditions. Two passes are built with the same material while a third pass is built with a different material.

Cross-Flow Heat Exchanger:

Designed with one fluid mixed and the other fluid unmixed.

Shell-and-Tube Heat Exchanger:

A 1-1 configuration which can be operated under either parallel-flow or counterflow conditions.

Free Convection Heat Exchanger:

Designed to provide air cooling of a pipe by free convection.

The apparatus can be operated with either laminar or turbulent flow in the different heat exchangers. The heat exchangers can be used with water, steam and air as the working fluids. The different experimental combinations are:

- Water to air
- Water to water
- Steam to water
- Steam to air



Model H-6878-CDL 6-Pass Heat Exchanger Demonstrator with
Computer Data Logging option.
Dimensions: 78"H x 94"W x 31"D, Weight: 600 lbs.

Description

The Hampden **Model H-6878** 6-Pass Heat Exchanger Demonstrator includes all of the components designed to demonstrate practical measurements. This unit consists of the following:

Test Bench:

This bench is 78"H x 94"W x 31"D overall, consisting of two leg and base assemblies, and one test panel. The leg assemblies and bases are constructed out of code gauge 2" square mechanical tubing finished in instrument texture. The test panel is constructed of code gauge sheet metal with 4" formed back panel with 1-1/2" returns and is finished in instrument white enamel. This unit comes complete with two swivel and two locking swivel casters.

Test Panel:

Mounted on the test panel are two flowmeters with a $\pm 2\%$ full-scale accuracy, one digital thermocouple display meter cold junction compensated with a resolution of 0.1°C/0.1°F and accurate to within $\pm 0.4^\circ\text{C}/0.8^\circ\text{F}$ utilizing Chromel- Alumel thermocouples. The bench comes complete with 23 fixed thermocouples on the inlet and outlet of the 1/2" ID tubes of each heat exchanger pass and at the mixing valve. Also, two thermocouple probes are supplied which allow the taking of temperature readings at any point of the outer surface of each of the heat exchangers.

All Hampden units are available for operation at any voltage or frequency

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Description (continued)

The unit comes equipped with hot and cold fluid inlet ports to the mixing valve, an inlet port for the cold fluid and a separate inlet port for introducing steam into the unit. A mixing valve is supplied to control the temperature of the hot fluid and two (2) needle valves are supplied to control the flow rates (read by the flowmeters) through each side of the heat exchangers. Twenty-nine (29) ball valves and one (1) three-way valve are supplied to control both the direction of flow and to direct the flow to the heat exchanger loop in use. The ball valves allow easy recognition of whether a given line is open or closed.

The heat exchangers used on this unit consist of:

- Two 48" lengths of parallel-pipe made of a non-ferrous tubing and one 48" parallel-pipe made of a different metal.
- A 1-2 shell and tube arrangement.
- A cross-flow arrangement with one fluid mixed.
- A bare pipe which uses free convection to transfer heat.

Each of the heat exchangers are constructed so as to have nearly equal heat exchanger surface area and there is a separate cold liquid return. All of the piping except the exposed pipe is insulated with an exposed strip to permit a thermocouple probe to reach any point in the outer surface of each heat exchanger.

The apparatus is designed to permit the student to determine experimentally:

1. Logarithmic temperature difference for:
 - a) Double-pipe heat exchanger with parallel-flow
 - b) Double-pipe heat exchanger with counterflow
 - c) Shell-and-tube heat exchanger
 - d) Cross-flow heat exchanger
2. Heat Exchanger Effectiveness for:
 - a) Double-pipe heat exchanger with parallel-flow
 - b) Double-pipe heat exchanger with counterflow
 - c) Shell-and-tube heat exchanger
 - d) Cross-flow heat exchanger
3. Heat Transfer Coefficients for both forced and free convection for laminar, transitional and turbulent flows for:
 - a) Liquid to liquid
 - b) Liquid to gas with a phase change
 - c) Gas to gas with a phase change
4. Film coefficients for:
 - a) Liquids
 - b) Gases with a phase change
5. Effects of different metals on thin wall heat transfer.
6. Tube entrance effects on heat transfer.
7. Unsteady state heat transfer.
8. Total heat balance.

Supplied with this unit is a Experiment Manual and Teacher's Manual. The Experiment Manual also gives the user a background in boundary layer theory and empirical relations for the calculation of the heat transfer coefficients. Analytical and graphic means for determining correction factors to the logarithmic mean temperature differences and calculating the effectiveness of a heat exchanger is also provided.

Services Required

Electrical:

- 120/240V.AC volts, 1 ϕ , 50/60Hz.

Water Supply:

- 6 GPM cold water
- 6 GPM hot water

CDL Option

The Hampden **Model H-6878** can be configured to accomplish Computer Data Logging (add suffix **-CDL** to Catalog No.). This option, which must be specified at time of order, utilizes dual thermocouples, each of the second thermocouples terminating to access receptacles.

In addition, the two rotameters are replaced with flow transmitters and digital indicators with recorder outputs, thus allowing flow and temperature to be monitored and recorded externally by owner provided recording and interface equipment.

This option provides the **Model H-6878** 6-Pass Heat Exchanger with the capability of data acquisition by National Instruments I/O modules interfaced into a PC computer through the USB port. Templates for LabVIEW® control software are included. Computer and National Instruments LabView® are not included.

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